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A NEW TREATISE OF ARITHMETICK.

In Three Parts.

The *First*, Containing all the Common *Rules* of ARITHMETICK, in whole *Numbers* and *Fractions*, both *Vulgar* and *Decimal*.

The *Second*, The Demonstration of those *Rules*.

The *Third*, The Use and Application of it in the *Exchequer*, *Custom-House*, *Excise*, *Pay-Offices*, &c. with some Practical *Rules*, *Notes*, and *Questions*, not hitherto Publish'd.

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To the Honourable

Henry Ferne, *Esq;*

Receiver General of Her Majesty's Customs, at the Port of *London*.

SIR,

T*HE desire of publickly Expressing my respects to you, for the many particular Favours you have been pleased to confer upon me, has been the*

great Motive of my presuming to present you with this Treatise of Arithmetick, *which, I humbly desire, may be as the result of Gratitude, from*

Honoured Sir, your most

Obliged Humble Servant,

W. Alingham.

TO THE

READER.

TO Speak of the Excellency of *Arithmetick* will be needless, it being of such immediate and universal Use, that nothing can be transacted without some Knowledge therein; for 'tis not only absolutely necessary for those who are Conversant in all kind of Trading and Dealing, but is also highly requisite for Persons of all Professions and Conditions.

Plato tells us, without Arithmetick, neither Science nor Republick could subsist, and that Prudence and Reason would be

banished out of the World, if the Science of Numbers were lost.

The Ingenious Jesuit *Clavius*, saith, the knowledge of Numbers Polisheth and Illustrates the Mind, causing it to argue Wisely and Punctually in other Sciences.

St. *Austin*, C. 2. *Doct. Chr. Cap.* 16. saith, that without Arithmetick, there is no understanding several Passages in *Holy Scripture*. And so St. *Jerom*, Tom. 1. Epis. 1. mentions, that Numbers have a Marvellous turn, to the discovery of many things in *Sacred Writ*; nay, there are some Passages in *Scripture*, that seem to impose upon us the necessity of Learning Arithmetick, as the *Unjust Steward*, and that of the *Master* of a *Family*, who took a long Journey, &c.

In

In short, 'tis the knowledge of Arithmetick, that renders Men reasonable, and gives them *Penetration*, *Order* and *Clearness* in their *Ideas*, and consequently raises them above their Nature, by a subtile reasoning where the Senses have no part.

Wherefore I shall no longer insist upon the Excellency of Arithmetick, but proceed to give the Reader a short Account of the following Book, which I have *Entitul'd*, *A new Treatise of Arithmetick*.

Wherein I have endeavoured to exhibit the first Principles thereof, both in whole Numbers and Fractions, after such method as I had found in my Practise of Teaching, to be most short and easie. But particularly the *Fractions*, both

Vulgar

Vulgar and *Decimal*, (the most knotty part) I will be bold to say, are so methodically Digested and Illustrated, as will render them intelligible to the meanest Capacity.

In the Second part of this *Treatise*, I have given the Demonstration of most of those Rules, both in whole Numbers and Fractions, and have also shown you *Gradation* how to raise several *Theorems*, by which most Questions, both in Simple and Compound Interest are solv'd; as likewise for buying and selling *Estates*, *Annuities* and *Pensions*, also *Fining* off *Rents*, &c.

Lastly, I have apply'd it to Practise, not only in Examples drawn from common Commodities; but also in things of another Nature, as *First*, in Relation to several Offices, *Particularly* the *Exchequer*,

Custom-

Custom-House, *Excise*, with the manner of Computing Soldiers and Seamen's Wages. Also how the Deductions of *Poundage*, *Off-Reckonings*, *Royal Hospital* and *Agency*, are taken and accounted for; in each of which I have given several short Rules, now Practised by Officers concern'd in those Offices and Accounts. *Secondly*, I have added a few Questions, which will be as pleasant in Knowing and Reading, as in answering by Arithmetick, they being Matters of Fact taken from History or Experience, by which means the Mind is doubly inform'd at the same time, which Attempt will make this Book differ from all Arithmeticks, now published in *English*.

These are, in short, the Principal things herein contain'd, what

I have elſe to ſay, is, That if in what is here delivered, any miſtake be Committed, or ſome things not ſo clear expreſt, as they might have been, I deſire my Reader to conſider, that (beſide my troubleſome buſineſs of Teaching, while I was Writing this) the Preſs, and our Natures are alſo Cauſes of ſuch Effects, *Faults* ever attending the former, and *Frailty* the later, and tho' undoubtedly it will meet with *Momus*, yet I hope there are ſome will kindly accept of what is here offered, and freely pardon the Errors, remembring they are Humane.

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THE

OF

ARITHMETICK.

A*Rithmetick* is the Art of right and true Reckoning, the Subject of which is *Number*, and is that unto which all the precepts of Computation hath relation.

Number is that by which the Quantity of any thing is expressed, as the *Unite* is the quantity by which one thing is expressed, and *Two* the quantity by which it is named two, *&c.*

Hence therefore 'tis evident how the Ancients were mistaken, who said, That *Unity* was the beginning of Number, and yet of it self no Number, which is altogether disagreeable to the Principles of *Geometry*, *Musick*, *Time*, &c. whose beginnings are a *Point*, a *Sound*, a *Moment*, *&c.* and are all defined indivisible, *i. e.* not to be divided into parts; but an Unite may be di-

vided into parts, and therefore cannot be the beginning of number. So that if what is divisible cannot be the beginning of number, then it must be (o) a *Cipher* or *Nothing*, for whatever is greater than nothing is divisible; And as a Point in Geometry is defined to be the beginning of Magnitude, yet of it self no Magnitude; so may a Cipher be said to be the beginning of Number, yet of it self no number.

Now an Unite is a number (as before was noted) for 'tis part of the same matter that is the whole, and by *it*, and *it* alone, several things are numbred, as One *God*, One *World*, *&c.* Therefore it cannot be the beginning of number.

But here Note, that though Unity be not the beginning of Number, yet 'tis the beginning of Multitude, For Multitude is only a Collection of Unites.

Number is either whole or broken, whole numbers we call *Integers*, and broken Numbers *Fractions*. A whole Number consists of one or many Unites; a broken number or Fraction, of part or parts of an Unite.

The Common Notes or Characters, by which we express Numbers, whether whole or Broken, are one of these following, *viz.* 1 2 3 4 5 6 7 8 9 0, The later of which, tho' of it self it signifieth nothing, yet when joined on the right hand of any one, or more,

of

of the aforeſaid Figures, encreaſeth their Value ten times.

In numbers of any ſort, there are two Principal things to be conſidered, *viz.* *Notation*, and *Numeration*.

Notation is, what the Vulgar call, or take, for *Numeration*, and is that which teacheth how to deſcribe any Number by the aforeſaid Characters; Or, it teacheth how to read the Value thereof being ſo deſcribed.

Numeration is the manner of working, or Operating, with Numbers, or 'tis that by which, with certain given Numbers, we diſcover an unknown Number: It hath 4 Species, or Parts, *viz.* *Addition*, *Subtraction*, *Multiplication* and *Diviſion*, of which we ſhall hereafter treat.

The true manner of Expreſſing, or noting Numbers Conſiſts in the knowledge of two things, *viz.* The Order of Places, And the Value of Each Place.

The Places that any Number is ſaid to have, are only the Number of Figures, or Characters, that repreſents it, as the Number repreſented by 235 conſiſts of three Places.

The Order of Places is from the right hand toward the left, as in the Number 476, the Figure 6 is in the firſt Place, the Figure 7 in the Second place, and the Figure 4 in the Third: So alſo in this Num-

ber 8730, the Cipher is in the First place, 3 in the Second, 7 in the Third, and 8 in the Fourth.

The First place of a Number, which is the Figure next the right hand, as was hinted, is called the place of Unites; for in this place any Figure signifies only its own value, so in the Number 327, here 7 is in the First place, and signifies only so many Unites, or Ones.

The Second place in a Number is called the place of Tens, in which any Figure signifies so many Tens. As it contains Unites, as in the Number 327, the Figure 2 is in the Second place, and signifies two Tens, or Twenty.

The Third place in a Number is termed Hundreds, in which any Figure signifies so many Hundreds as there are Unites in the said Figure, as in the aforesaid Number 327, the Figure 3, is in the place of Hundreds, and signifies 3 Hundred, so that if it be required to read or Express this Number 327, you must begin at the Left Hand, according to the preceding Directions, and pronounce it Three Hundred Twenty Seven; likewise this Number 307, is thus Read, Three Hundred and Seven; Understand the like of others: The Fourth place (if you have more places than three in the Number) is Thousands; the Fifth place Tens of Thousands; the Sixth place Hun-

dreds of Thouſands; the Seventh place Millions; the Eighth place Tens of Millions; the Ninth place Hundreds of Millions; the Tenth place Thouſands of Millions; and ſo on.

Now, ſuppoſe this Number 9876543210 was given to have its Value Expreſſed, then from the foregoing Direction I Proceed to Pronounce it thus, Nine Thouſand, Eight Hundred Seventy Six Millions; Five Hundred Forty Three Thouſand, Two Hundred and Ten.

From what precedes, 'tis very eaſy by theſe Characters, either to Denote any Summ you hear Expreſſed in Words, or to Expreſs in Words what you find Denoted by theſe Characters; in doing which, the following Table will much aſſiſt you.

Notation, *vulgarly call'd* Numeration Table.

Hund. of Mill.	9								
Tens of Mill.	8	9							
Millions.	7	8	9						
Hund. of Thous.	6	7	8	9					
Tens of Thous.	5	6	7	8	9				
Thousands.	4	5	6	7	8	9			
Hundreds.	3	4	5	6	7	8	9		
Tens.	2	3	4	5	6	7	8	9	
Unites.	1	2	3	4	5	6	7	8	9

Nine.
Ninety Eight.
Nine Hundred Eighty Seven.
Nine Thousand Eight Hundred Seventy Six.
Ninety Eight Thousand Seven Hundred Sixty Five.
Nine Hund. Eighty Seven Thous. six Hund. Fifty four.
Nine Mill. Eight Hund. Seventy six Thous. five Hund. forty three.
Ninety Eight Mill. 7 Hun. Sixty five Thous. 4 Hund. Thirty Two.
Nine Hund. Eighty 7 Mill. six Hund. Fifty 4 Thous. 3 Hund. 21.

From

From the nature of this Table 'tis manifest, that a Cipher on the left hand of any parcel of Figures doth not increaſe or decreaſe its Value, For 054, is of the ſame value with 54: likewiſe from this Table may any Number of places of Figures be Valued, Tho' I have gone no farther than nine places, the laſt of which is Hundreds of Millions, and if you went on, the next would be Thouſands of Millions, the next Tens of Thouſands of Millions, the next Hundreds of Thouſands of Millions, the next Thouſands of Thouſands of Millions, or Millions of Millions, the next Tens of Millions of Millions, and ſo on; or by putting a point to every Sixth Figure from the Right hand you may by inſpection determine the Value of any parcel of Figures, For the firſt Six Figures next the Right Hand, denote Hundreds of Thouſands, the Second Six Figures Hundreds of Thouſands of Millions, the Third 6 Figures Hundreds of Thouſands of Millions of Millions, &c.

As ſuppoſe theſe 18 Figures ſo placed and pointed 574326,891765,423891, were given to be numbred or Valued; I pronounce the Number thus, Five Hundred, Seventy Four Thouſand, Three Hundred, Twenty Six Million of Millions, Eight Hundred, Ninety One Thouſand Seven Hundred, Sixty Five Millions, Four Hundred, Twenty

Three Thousand, Eight Hundred Ninety One: And after this manner may you Express the Value of any greater Number of Figures.

ADDITION.

Teacheth you how to Reckon, Collect or Gather together several Sums into one Total, or whole Summ, which Total or whole Summ, is also called the Agregate.

Rule, Set the several Sums (if they be of one Denomination) one under another, that is Unites under Unites, Tens under Tens, Hundreds under Hundreds, *&c.* and underneath them draw a Line, then begin to add with the lowest Figure next your Right Hand, and Collect all the Figures in that rank quite to the top into one Sum ; set down the odd Unites above the Tens, and for so many Tens as there are, carry so many Unites to the next rank of Figures, proceed thus with the rest of the Ranks, *that is*, set down the Unites, and carry the Tens, only whatever the last row or rank comes to, that must be wholly set down to the former Figures.

For

For Example, in the first Sum I begin with 9, saying 9 and 4 is 13, and 8 is 21, and 5 is 26, and 6 is 32, then I set down 2, and carry the 3 Tens to the bottom Figure of the new Row, it makes 6 and the 5 above is 11, and 4 is 15 and 2 is 17, and 3 is 20, which 20 I set down to the former 2, and it makes 202, which is the Total, or whole Sum.

Integ.	*Integ.*	*Integ.*	*Integ.*
36	23	534	3826
25	37	356	2547
48	45	438	1398
54	26	567	4576
39	38	479	3489
202	169	2374	15836

If the Quantities, or Numbers to be added be of divers Denominations, as *Pounds*, *Shillings*, *Pence*; *Pounds*, *Ounces*, *Drams*, or any thing else, then you must place those of the same Denomination, that is, of the same Name, under each other, *viz.* Pence under Pence, Shillings under Shillings; and Pounds under Pounds, after which draw a Line under them, and begin your Addition first with the least Denomination, which is always placed next your right hand, minding how many of these less, are contained

tained in the next greater Denomination; and ſo many Times as you find, ſo many Ones, or Unites, carry to the next Denomination, as you did the Tens before, ſetting down the odd remainder if any be; Proceed thus with the reſt of the Denominations, till you have gone through them all, if there be never ſo many. See the Examples of Money following.

l.	*s.*	*d.*	*l.*	*s.*	*d.*	*l.*	*s.*	*d.*
3	7	9	49	19	11	27	11	10 $\frac{1}{2}$
2	9	11	36	8	10	36	19	11 $\frac{1}{4}$
7	11	10	24	19	11	24	15	10 $\frac{3}{4}$
4	16	11	38	4	6	36	17	6 $\frac{1}{2}$
8	13	7	24	11	10	29	13	00 $\frac{1}{4}$
27	0	0	174	5	0	155	18	3 $\frac{1}{4}$

Note, that *l. s. d.* ſtands for *Libra*, *Solidus*, *&* *Denarius*, that is, a *Pound*, *Shilling* and *Penny*, the *Farthings* are generally writ Fraction-wiſe, that is, with two Numbers thus, as $\frac{1}{4}$, is one farthing, $\frac{1}{2}$, is one Half-Penny, or two Farthings, $\frac{3}{4}$, is Three Farthings; Obſerve alſo, that in Addition ſome uſe the Method of Pointing; as at every 12, in the Pence, they make a point, and ſo many points as are made

made in the whole Addition of your Pence, so many must be carried to the place of Shillings, setting down the remains above 12, under the place of Pence; so likewise at every 20, in the Shillings, make a speck, and so many specks as you find in the Addition of your Shillings, carry so many to the Pounds, setting down the overplus Shillings, and then go on to the Addition of your Pounds, whether there be one, two, or more rows,

But the Method I would commend to the practice of such that are frequently concerned in the Collection, or adding up of large Summs is this, Add up the Pence, and make a point at every 60, which is 5 Shillings, (as is Evident by the following Table, and from which you may readily know how many Shillings and Pence any number of Pence is, under 120,) proceed thus, to the Top of the Pence row, set down the odd Pence, and carry the Shillings to the place of Shillings; adding up only the place of Unites in the Shillings first, in which no stop need be made, only set down the odd Shillings above the Tens, and carry the Tens to the place of Tens in the Shillings, counting them but as Ones or Unites, that is, for so many Angels, then for the Sum of Angels in the Second place, take half of it for the number of Pounds, because two Angels is one Pound, setting down the odd

odd Angel, if there be one, as ſuppoſe it came to 9 Angels, then the odd Angel muſt be ſet down as one to the place of Unites in the Shillings, and the half is carried to the place of Pounds. By the uſe and practice of this way, you'l find your ſelf much readier, and quicker in caſting up large Sums, than by any other.

The Table of Pence.

d.		s.	d.
20	is	1	8
30	is	2	6
40	is	3	4
50	is	4	2
60	is	5	0
70	is	5	10
80	is	6	8
90	is	7	6
100	is	8	4
110	is	9	2
120	is	10	0

The

The Proof of Addition.

TO prove *Addition*, ſtrike off the upper Number with a daſh of the Pen, and add up all the Sum again, except the upper Line, which is ſtruck out ; This done, Add the ſecond Sum to the upper Row ſo ſtruck out ; If they both together make the firſt Total, the Work is right, otherwiſe not. See the following Example.

l.	*l.*	*s.*	*d.*
35	24	10	9
27	36	8	10
36	27	19	11
94	38	14	10
38	26	15	11
230	154	10	3
195	129	19	6
230	154	10	3

Mr. *Record* ſhows another way of proving *Addition*, as may be ſeen in the 41ſt. page of his Arithmetick, but I count this the ſureſt.

Some

Some Examples in Addition.

Suppose I received for 3 days together, 5 *l.* 17 *s.* 4 *d.* $\frac{1}{2}$ how much is that in all. *Answ.* 17 *l.* 12 *s.* 1 *d.* $\frac{1}{2}$.

Suppose I Received upon several days the following Sums, *viz.* First 2 *d.* $\frac{3}{4}$. Secondly 8 *l.* 13 *s.* Thirdly 9 *s.* 8 *d.* Fourthly 4 *l.* 17 *s.* 2 *d.* $\frac{1}{2}$. Fifthly 5 *l.* 17 *s.* 6 *d.* what is the Summ of all I have received. *Answ.* 19 *l.* 17 *s.* 7 *d.* $\frac{1}{4}$.

What Summ is that, from which if I take 4 *l.* 10 *s.* 11 *d.* $\frac{1}{2}$. there shall remain 11 *l.* 15 *s.* 9 *d.* $\frac{1}{4}$. *Answ.* 16 *l.* 6 *s.* 8 *d.* $\frac{3}{4}$.

What Summ of Money is that, from which if I take away 19 *l.* 14 *s.* 3 *d.* $\frac{3}{4}$. there shall remain 150 *l.* *Answ.* 169 *l.* 14 *s.* 3 *d.* $\frac{3}{4}$.

SUB-

SUBTRACTION.

Eacheth you how to take a lesser Number from a greater, and sheweth you what remains: Or it shows you how to find the Remainder, Excess, *or* Difference *betwixt any two Quantities.*

Rule, As in Addition, so in Subtraction, you must take care (whether the Summs given, be of one or many Demominations) that they be set down in order, one under another, As if they be of one Denomination, see that Unites stand under Unites, Tens under Tens, and Hundreds under Hundreds, *&c.* If they be of different Denominations, as *Money*, *Weight*, *Time*, *&c.* then see that each respective Denomination be set under its like; that is Farthings under Farthings, Pence under Pence, *&c.*

This being done, begin at the first Figure next the Right-hand, and operate thus, 4 from 5, there remains 1, which I set underneath the 4, 5 from 3 I cannot, but 5 from 13 there remains 8, 1 that

that I borrow'd and 2 is 3, 3 from 5 there remains 2, then 8 from 6 I cannot, but 8 from 16 there is left 8; Laſtly, 1 that I borrow, and the laſt 3 is 4, this I take from 8, there is left 4, which I ſet under its proper Figure, as I have done all the reſt. So is the whole remainder 48281, and the operation is finiſhed.

Integers.	*Integers.*	*Integers.*
86535	56523	67543
38254	17256	23432
48281	39267	44111

In Subtraction of Money, Weight, Meaſure, *&c.* you muſt borrow a whole Integer of the next greater Denomination, as ſuppoſe in Money, I was to take 10 *d.* from 8 *d.* here I borrow a whole Shilling, *i. e.* 12 *d.* and add to the 8 which makes 20, ſo that I take 10 from 20, and ſet down the remainder underneath; Underſtand the like of all others, that is always remember to borrow a whole *Integer* of the next greater Denomination; as you ſee is done in the following Example.

Example.

Examples.

	l.	s.	d.	l.	s.	d.	l.	s.	d.
Lent	546	10	08	356	19	06	262	14	01 $\frac{1}{4}$
Paid	294	11	10	211	01	07	198	16	07 $\frac{1}{2}$
Rem.	251	18	10	145	17	11	63	17	05 $\frac{3}{4}$

The Proof of Subtraction.

It is evident that the Remainder, and Sume Subtracted, must make up the Sume out of which the Subtraction was made: Add therefore the Remainder and Sume paid together, and if they both make the Sume Lent, the Work is right, otherwise not.

See the following Examples.

	l.	s.	d.	l.	s.	d.
Lent	625982	14	10	102324	01	07
Paid	235826	17	11	98234	14	09
Rem.	390155	16	11	04089	06	10
Proof	625982	14	10	102324	01	07

More Examples.

Lent 17 *l.* 12 *s.* 01 *d.* $\frac{1}{2}$. Paid of this 11 *l.* 14 *s.* 09 *d.* What is left to pay. *Answ.* 5 *l.* 17 *s.* 04 *d.* $\frac{1}{2}$.

Lent 19 *l.* 17 *s.* 07 *d.* $\frac{1}{4}$. of which there is paid at one time 09 *s.* 08 *d.* at another 2 *d.* $\frac{3}{4}$, at at third 8 *l.* 13 *s.* at a fourth 4 *l.* 17 *s.* 2 *d.* $\frac{1}{2}$. What doth yet remain. *Answer*, 5 *l.* 17 *s.* 6 *d.*

What Sume of Money is that, to which if I add 11 *l.* 15 *s.* 09 *d.* $\frac{1}{4}$, the Sume shall be 16 *l.* 06 *s.* 08 *d.* $\frac{3}{4}$. *Answer* 4 *l.* 10 *s.* 11 *d.* $\frac{1}{2}$.

What Sume of Money is that, to which if I add 19 *l.* 14 *s.* 03 *d:* $\frac{3}{4}$. it shall make 169 *l.* 14 *s.* 03 *d.* $\frac{3}{4}$. *Answer* 150 *l.*

And here note, That 'twill be necessary for the young Arithmetician to exercise himself both in Adding and Substracting Sumes of *Weight*, *Measure*, *Time*, &c.

MUL-

MULTIPLICATION.

It compendiously performs the Work of many Additions, and teacheth how by two given Numbers to find a third, which third Number shall contain either of the two given Numbers, so oft as the other contains 1 or Unity.

As suppose 8, is to be multiplied by 3, then if by Addition you collect the Sume of three Eights, or Eight Three's, it will give you the same as if you had multiplied 8 by 3, or 3 by 8, which is 24.

One of the two given Numbers is called the *Multiplicand*, and is the Number to be Multiplied.

The other is the *Multiplyor*, being that by which we Multiply.

And the Number arising from the Multiplication is called the *Product* or *Fact*.

Hence it matters not which of the two given Quantities you make the *Multiplicand*, or which the *Multiplyor*, for 8 multiplied by 3, is the same with 3 multiplied by 8; tho' for convenience sake, we ge-

nerally multiply the biggest Number by the least.

The reason also of that common Notion in Multiplication is hence manifest, that the *Multiplicand* is to be put so often to it self, as there are Units in the *Multiplior*.

From whence it follows, that all Quantities multiplied by a Fraction are decreased, *that is*, the Product of two Quantities, of which one is a Fraction, is always less than either of those Quantities; for the *Product* will be only part of the *Multiplicand*, because the *Multiplyor* is but part of *Unity*.

Now for expediting the Practice of this Rule, it is absolutely necessary to get the following Table by heart.

Multi-

Multiplication TABLE.

2 times	2	is	4
	3		6
	4		8
	5		10
	6		12
	7		14
	8		16
	9		18
	10		20
	11		22
	12		24

3 times	3	is	9
	4		12
	5		15
	6		18
	7		21
	8		24
	9		27
	10		30
	11		33
	12		36

4 times	4	is	16
	5		20
	6		24
	7		28
	8		32
	9		36
	10		40
	11		44
	12		48

5 times	5	is	25
	6		30
	7		35
	8		40
	9		45
	10		50
	11		55
	12		60

6 times	6	is	36
	7		42
	8		48
	9		54
	10		60
	11		66
	12		72

7 times	7	is	49
	8		56
	9		63
	10		70
	11		77
	12		84

8 times	8	is	64
	9		72
	10		80
	11		88
	12		96

9 times	9	is	81
	10		90
	11		99
	12		108

10 times	10	is	100
	11		110
	12		120

11 times	11	is	121
	12		132

12 times	12	is	144

Rule. The Table being perfectly learnt by heart, proceed to the Method of Operating thus: The Numbers to be multiplied muſt be ſet one under the other, it matters not whether the greater be upper or lower, or whether you place Unites under Unites, *&c.* tho' for methods ſake we commonly ſet the biggeſt Number above, and the other under it, placing Unites under Unites, Tens under Tens, &c.

The Numbers being thus placed, as in the following Examples appear, I begin with the firſt of them, ſaying, 4 times 9 is 36, I ſet down 6 and carry 3, then 4 times 7 is 28 and 3 is 31, ſet down 1 and carry 3; next 4 times 2 is 8 and 3 is 11, that is 1 and carry 1, then 4 times 6 is 24 and 1 is 25, I put down 5 and carry 2; next 4 times 5 is 20, and 2 is 22, that is 2 and carry 2, then 4 times 3 is 12 and 2 is 14, which I ſet down it makes the Product 1425116; and thus is the Operation finiſh'd.

Multiplicand	356279	6875627	236891
Multiplior	4	8	9
Product	1425116	55005016	2132019

In multiplying by 2, 3, or more Figures, the product of the firſt figure next the right hand is to be ſet down as it was in the multi-

multiplication of one figure, the product of the second figure must be set down under the former a figure short, that is, the first figure in this product must be set under the second figure in the first product; and so if their be 3, 4, or more places in the *Multiplior*, you must set the first Figure of the third product a figure short of the second, and the first figure of the fourth a figure short of the third, and so a figure short every line, that is, Unites in the later Product must stand under Tens in the former, observing also to keep the Figures directly under one another. Having thus gone thro' all the figures of the *Multiplyor*, and plac'd them as before directed, cast them up, beginning at the single Figure next the right hand, and proceed to the left, as in Addition, the Summe of these single Products is the whole Product of the two given Numbers. See the following Examples.

```
  3846         6374
    24          346
 -----       -------
 15384        38244
 7692        25496
 -----       19122
 92304       -------
 =====       2205404
             =======
```

Abreviations in Multiplication.

And here observe, that if the *Multiplicand*, or *Multiplyor*, or both, have a Cypher or Cyphers in the last place, you need only multiply by the Figures, setting the number of Cyphers that are both in *Multiplicand* and *Multiplyor*, on the right hand of the Product of the Figures, and it will give the Product of the proposed Quantities.

The Example.

```
  34400        846
    600        450
 --------    ------
 20640000     42300
             3384
             ------
             380700
             ------
```

Hence 'tis evident, That to Multiply any parcel of Figures by 10, 100, 1000, &c. is only to put one, two or three Cyphers at the end, or right hand of them, for that will make the Product.

```
  1869      100000
   100          10
 ------    -------
 186900    1000000
 ------    -------
```

Secondly

Secondly, If you would multiply any Quantity by 5, Add a Cypher at the end of it, and then take half the Number, and it shall be the Product required. See the following Example.

$$\begin{array}{r} 36792 \\ 5 \\ \hline 367920 \\ \hline 183960 \\ \hline \end{array}$$

Thirdly, The preceding Table being perfectly learnt, 'tis easy to multiply by 10, 11, or 12, and make but one Line; as suppose 432 to be multiplied by 12, then instead of multiplying by 2 and 1, Multiply by 12, saying, 12 times 2 is 24, set down 4 and carry 2; then 12 times 3 is 36 and 2 I carried is 38, that is 8 and carry 3; Lastly 12 times 4 is 48 and 3 is 51, which 51 I set down entirely to the 84 it makes 5184, the Product of 432 multiply'd by 12.

$$\begin{array}{r} 432 \\ 12 \\ \hline 5184 \\ \hline \end{array}$$

Fourthly, If there happen a Cipher in the middle of your *Multiplyor*, you need do no more but put a Cipher under the second Figure

Figure of the preceding Product to fill up its room, and ſet down the firſt figure of the next Product on the left hand of the Cipher in the ſame Line; as is evident by the following Example.

$$\begin{array}{r} 543 \\ 204 \\ \hline 2172 \\ 10860 \\ \hline 110772 \\ \hline \end{array}$$

The Proof of Multiplication.

The trueſt way to prove *Multiplication* is by *Diviſion*, but that being not yet learn'd cannot be uſed, and therefore I ſhall ſhow the common way by the Croſs, which is thus,

Make a Croſs, then caſt away 9 ſo oft as you can out of the *Multiplicand*, and what remains ſet on one ſide of the Croſs, do the like by the *Multiplior*, and ſet the remainder on the oppoſite ſide of the Croſs, multiply theſe two Numbers together, and from the Product caſt away all the 9's you can, the remainder ſet on the top of theCroſs; Laſtly, caſt away the 9's from the Product, what remains ſet under the Croſs. If then the Figure at the top and bottom of the Croſs

Croſs are the ſame, the Work is right, elſe there is an Errour. See the Proof of the following Example.

$$\begin{array}{ccc} & 5 & \\ 7 & \times & 2 \\ & 5 & \end{array} \qquad \begin{array}{r} 367 \\ 38 \\ \hline 2936 \\ 1101 \\ \hline 13946 \\ \hline \end{array}$$

More Examples.

If a Traveller goes 29 Miles in one Day, how many Miles will he go in 17 Days? *Anſwer*, 493 Miles.

If I gave 35 l. a piece to 796 Men, how much was the whole given away. *Anſwer*, 28860 l.

A certain Summe of Money is divided betwixt 98 Men, their Shares came to 14 l. each, how much Money was Diſtributed in all? *Anſwer*, 1372 *l.*

The Share of the Cargo in a Ship is equally divided betwixt 178 Men, each Man having to his Share 37 *l.* What was the whole Cargo in the Ship worth? *Anſwer*, 6586 *l.*

DIVISION.

DIVISION.

IT *undoes* Multiplication, *and performs in short the Work of many* Substractions, *and teacheth to find how often one Number contains, or is contain'd by another; or it showeth how to divide a Number into any equal parts.*

As suppose 12 was given to be divided by 3, *that is*, 'tis required to find how many 3's there are in 12; Here 12 is the Number to be divided, and is therefore called the *Dividend*; The Number 3 is that by which we divide, and therefore is called the *Divisor*: Lastly, the number of times that 12 contains 3 (which is 4) is called the *Quote*, from *Quoties*, because it shows *how oft* the Dividend contains the Divisor; and if any thing remain after the Division is ended, then is such Number called the *Remainder*.

Hence it follows, that so oft as the Dividend contains the Divisor, so oft doth the Quote contain 1 or Unity.

Or (from the Principles of *Multiplication*) that the Dividend contains the Quote, ſo oft as the Diviſor contains Unity.

From whence 'tis evident, that if the Diviſor be leſs than Unity, the Quote will be greater than the Dividend.

As alſo, that if you divide any Product by the Multiplior, the Quote will be the the Multiplicand, which is the ſureſt Proof of *Multiplication.*

Rule. The manner of operating in this Rule, is differently ſet down by ſeveral Authors ; I ſhall not therefore enlarge upon the Rules and Directions of each particular, but ſhall proceed to ſhew you the plaineſt, and that which is moſt uſually practized in the beſt Schools, and by thoſe who are converſant in ſuch Operations, which Method is as follows.

Place the Dividend between two crooked Lines, and the Diviſor on the left hand of the Dividend, as in the following Example ; this done, obſerve that in working Diviſion Three things muſt be particularly heeded, *viz.* Firſt, to *Seek* ; Secondly, to *Multiply* ; And Thirdly, to *Subſtract* : This noted proceed, by Asking how oft 7 is in 8 (the firſt Figure in the Dividend) the Anſwer is 1, this I ſet in the other crooked Line, on the right hand of the Dividend ; then multiplying 7 by 1 gives 7, which I ſet under 8, and Subtract there-

from ;

from ; the Remainder 1 I ſet underneath, and to it bring down 4, the next figure in the Dividend ; then I ſeek again how oft 7 is in 14, I find 2, which I ſet in the Quote on the right hand of the former figure 1, multiplying 7 thereby which gives 14, this Subtract therefrom leaves nothing ; then I bring down 6, the third Figure in the Dividend ; and becauſe I cannot take 7 out of 6, I ſet down 0 in the Quote, and bring down 2 the laſt figure in the Dividend to 6, and ſeek how oft 7 is in 62, which I find to be 8, this 8 I ſet in the Quote, and multiplying 7 thereby the Product 56 I ſubſcribe under 62, and taking it therefrom leaves 6 remaining, and gives 1208 for the Quote ; all which plainly appears by the firſt of the following Examples.

And here note, that if the Remainder is more than the Diviſor, the work is not rightly perform'd : But this Errour is eaſily rectified, by taking either the laſt, or ſome other figure in the Quote 1,2 or 3 more.

7)8462(1208	9)41562(4618
7	36
14	·55
14	54
·062	·16
56	9
·6	·72
	72
	··

In

In Dividing by two, three or four Figures there is more difficulty, the reason of which I conceive is this; there is no certain Rule can be prescribed to know what Number of times upon each Demand the Divisor is contained in the Dividend, till you have made a tryal, by taking the first figure a certain number of times, and then trying whether you can take the product of that figure (thus found) into all the other figures of the Divisor, out of those figures in the Dividend, which stand over these figures in the Divisor.

The manner of operating, when we divide by several figures, is thus, Suppose I would divide 3278 by 19; having plac'd the Dividend and Divisor, as in the last, I ask how oft the first figure 1 is in 3, which is but once, for there is but once 19 in 32, tho' there is three times 1 in 3; by this 1 I multiply 19, and setting the Product under 32 the first part of the Dividend, I substract as before, bringing down to the remainder 13, the next figure in the Dividend which is 7, just as I did by dividing in one figure; then I ask how oft 1 is in 13, I find but 7 times, for if I take 8 times, the remainder 57 will not be sufficient to take 8 times 9 out of (for this is the greatest difficulty, *viz.* to know when you take the first figure whether the second figure will bear it) this 7 I set in the Quote, and multi-

multiplying thereby, ſetting 133 the Product under the former Dividend, which done I ſubſtract it therefrom, and bring down 8 to the 4 remaining; ſo then it will be the Ones in 4, or the 19's in 48, which is 2, this I ſet in the Quote by the former 7, and multiplying 19 thereby, the Product 38 I ſet under 48, and Subſtract it therefrom, ſo is the remainder 10, and the Quote 172, as appears by the laſt of the following Examples.

```
38) 4896 (128        19) 3278 (172
    38                   19
    ———                  ———
    109                  137
     76                  133
    ———                  ———
     336                 ·048
     304                   38
    ———                   ———
     ·32                   10
```

Abreviations in Diviſion.

IF the Diviſor has one, or more Ciphers in the laſt place, that is, on the right hand, then for ſo many Cyphers as there are, cut ſo many places from the Dividend toward the right hand, whether they be Cyphers, or Figures, and divide the remaining

maining Figures in the Dividend, by the remaining Figures in the Divisor, and it will give you the Quote of the proposed Quantities.

Example.

```
7|00)865|20(123
     7
     --
     16
     14
     --
      25
      21
      --
       420
       ---
```

But here observe that whatever Figures were cut off in the Dividend must be brought down at last to the remaining Figures in the Divisor; to compleat the whole remainder, see the preceding Example.

Hence 'tis evident, that to divide any parcel of Figures by 10. 100. 1000, &c. is only to cut so many Figures from the right hand as there are Cyphers in such Divisor, so will the remaining Figures be the Quote.

Example.

1|000)6892|136(6892

Secondly, In dividing by 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 there is a ſhort Practical way (now frequently uſed by great Clerks) by which the multiplicity of Figures is avoided, and only what's abſolutely neceſſary ſet down, the manner of it is thus.

Example, Divide 756469 by 7, having ſet the Dividend with the Diviſor in a crooked Line, on the left ſide thereof draw a Line underneath, then enquire how oft 7 in 7, once and there remains 0, next the 7 in 5, no times, next the 7 in 56, 8 times, then the 7 in 4, no times, next the 7 in 46, 6 times, there remains 4, then the 7 in 49, 7 times, there remains nothing; all theſe Figures of the Quotient I place underneath the Line, as in the following Examples more plainly will appear.

7)756469(	5)658432(
108067	131686 2 *rem.*

Laſtly, Before I proceed to the proof of Diviſion, I ſhall inſert a Specimen of working one Sum in Diviſion nine different ways.

```
2                    2
342                   985(7
2985(7               35679(1372
35679(1372           26666
26666
                      222
 222
```

```
   2
   2                    2
  2985(7               985(7
26(35679(1372      26(35679(1372
  26822                26822
   785                  785
    2                    2
```

The two following are the *Italian* ways of working Division one of which they call the long the other the ſhort way.

```
26)35679(1372     26)35679(1372
   26
                     96
   96
   78                187
   187
   182                59
     59                7
     52
      7
```

```
   2                    1
  985(7                341
26)35679(1372         1985(7
                    26)35679(1372

                          (7
                         59
                        187
                        96
                      ------
                    26)35679(1372
                    ---26     -----
                        78
                        182
                          52
```

The Proof of Division.

ONe Proof of Diviſion is by Multiplication, and that's Infalible, for ſince the Quote ſhews how oft the Diviſor is contained in the Dividend; therefore if the Quote of any Diviſion be multiplied by the Diviſor, the Product muſt be equal to the Dividend, only if there be a remainder, that muſt be added in when you multiply.

There is alſo another certain way of proving Diviſion, and that's by Addition; for 'tis evident that the ſeveral Products of each particular Figure of the Quote, multiplied into the Diviſor with the remainder added together

together, as they ſtand in operation, will make up the Dividend; all which is evident by the following Example, where I have noted the ſeveral Products which are to be added by the Letter *a*.

A third Proof of Diviſion is by the Croſs (thus) we caſt the 9's out of the Diviſor, and ſet the remainder down in one ſide of the Croſs; next I caſt the 9's from the Quote, and ſet that remainder in that part of the Croſs oppoſite to the former, theſe two I multiply together, and having caſt the 9's out of the Product, I add the overplus to the remainder of the Diviſion, the Sum if under 9, elſe the exceſs above 9, ſet down in the upper part of the Croſs, then caſt all the 9's out of the Dividend and if there remain the like Figure there did in the Quote, the Work is right, otherwiſe not.

See the following Example proved all three ways.


```
39)798946(20485
   a78          39
   ---        ------
    189      184366
   a156      61458
   ----      ------
      334(798946
             ------
     a312
     ----
      226
     a195
     ----
      a31
   -------
   798946
   ------
```

More Examples.

If in 17 Days I Travel 493 Miles, how many Miles is that in one Day? *Answer*, 29 Miles.

If 27860 *l.* be given away to a certain number of Men, each Man 35 *l.* how many Men will it suffice? *Answer*, 796.

In

In 7656 Shillings, how many *French* Crowns, each Six Shillings? *Answer*, 1276.

The Cargo of a Ship is valued at 6586 *l.* this is to be distributed equally betwixt 178 Men, what shall each Man have for his share? *Answer*, 37 *l.*

The share of the Cargo of a Ship is worth 6586*l.* and having counted it among themselves finds it comes to 37*l.* *per* Man, the Question is how many Men there was in the Ship? *Answer*, 178.

Reduction.

REduction *is not properly any real Rule of* Arithmetick, *but rather an Application of* Multiplication *and* Division, *by which is shewn how to reduce or change any number of pieces of Coyne, Weight, Measure,* &c. *from one Denomination to another; which thing is of great use amongst Tradesmen in common Business, and sometimes this is from a lesser Name to a greater, and sometimes from a greater to a lesser, for the performance of which observe.*

First, That all great Names are brought into lesser by Multiplication.

Secondly, That all small Names are brought into greater by Division.

Thirdly, That the Dividend and Divisor must always be of one Name, that is, *both Shillings*, *both Pence*, *both Ounces*, *both Quarts*, *&c.* and that the remainder is of the same Name with either of them, to clear all I shall give an Example that will contain both Cases, with Directions and Notes upon the same.

In 354 *l.* 13 *s.* 2 *d.* how many Pistoles at 20 (17 *s.* 6 *d.* and Dantiprats at 1 d. $\frac{1}{4}$

7093
12
85118
4
340472 Pistoles at 17 *s.* 6 *d.*

17--6
12
210
4
840 Dantip. at 1 *d*, $\frac{1}{4}$

84)0)34047(2)405
336
447
420
272

5)340472(68094
30
40
40
47
45
22
20
2

First, Reduce the whole Sum of Money to Farthings, by reason one of the Denominations required have odd Farthings in them, and this is done by Multiplication, because 'tis a greater Name to a lesser.

Secondly, Bring each particular Piece to the lowest Denomination 'tis mentioned to contain.

Thirdly, By the number of Shillings, Pence, or Farthings contained in any one Piece; divide the number of the same Denomination contained in the whole Sum of Money propos'd, the Quote is the number of Pieces contained in the said proposed Sum.

But to be a little plainer (because I shall not give more Examples of this kind) I first multiply 354 *l.* by 20, the number of Shillings in a Pound, taking in the 13 Shillings, this brings them into Shillings, which Shillings I multiply by 12, because 12 Pence is one Shilling, adding in the odd 2 Pence, this brings the Shillings into Pence, which Pence I multiply by 4 to bring them into Farthings.

This done I take out 340472, the Farthings in 354 *l.* 13 *s.* 2 *d.* and divide them by 840, the Farthings in a Pistole, it gives 405, the number of Pistoles in 354 *l.* 13 *s.* 2 *d.* for so oft as 840 is contained in 340472 so many Pistoles is contained in 354 *l.* 13 *s.* 2 *d.*

Again I take out 340472, the Farthings in the aforemention'd Sum, and divide by 5, the Quote gives 68094 the number of Dantiprats contained in the said Sum.

But

But Note, that if I had divided 85118, the Pence in 354 *l.* 13 *s.* 2 *d.* by 210, the Pence in a Piſtole, the ſame Quote would have come out as in the preceding. In like manner, *Mutatis Mutandis*, may you reduce *Weight*, *Meaſure*, *Time*, &c. from one Denomination to another.

The Proof of this Rule.

There needs no farther Proof of this Rule, but to take care that your Multiplications and Diviſions are truly wrought.

More Examples.

In 237 *l.* 18 *s.* 5 *d.* how many Piſtoles at 17 *s.* 6 *d.* and Rix Dollars at 4 *s.* 2 *d?*

Anſwer. { 271 Piſtoles.
1142 Rix Dollars.

In 598 Piſtoles, each 17 *s.* 6 *d.* how many Pounds Sterling, and Guineas at 22 *s.*

Anſwer. { 523 Pounds Sterling.
475 Guineas.

In 683 Pieces of Eight, each 7 *s.* 4 *d.* how many Ducats at 5 *s.* 2 *d.* and Pounds Sterling?

Anſwer. { 969 Ducats.
250 Pounds Sterling.

Note, In theſe Queſtions there is ſomething commonly remaining, which I have taken no notice of.

The

The Golden Rule, or Rule of Three.

Being so called because it teacheth how by three given Numbers to find a fourth.

The greatest difficulty in this Rule is how to state the Question. To do which observe that the first and third Number be of one nature, that is, if the first is Money, the third must be Money. If the first be Weight, the third must be Weight. If the first be Time, the third must be Time, *&c.*

The second Number must be of the same Nature with that requir'd, which is the fourth; and therefore you cannot well miss placing the second Term aright; the third Term or Number is always known by its being immediately placed after *how much*, *what cost*, *what will*, and such like Words that ask the Question.

The Question being Stated, the first and third Number must be brought into one Name, and the middle Number must be reduced to the lowest Name mention'd. This done *multiply your second and third Term together when so reduced, the Product divide by the first, the Quote gives the Answer*

to the Question, in the same Denomination 'twas in before you multiply'd it into the third.

For Example.

Suppose 37 *l.* 16 *s.* 4 *d.* buy 86 Ells of Cloth, what will 3 Ells cost at the same Rate?

In this Question the second term must be Money, because that requir'd is so, the third term must be 3 Ells, because that immediately follows the Words *What will*, that ask the Question, and by Consequence the first term must be 86 Ells, it being the same with the third, and therefore I state it thus,

If 86 Ells——37 *l.* 16 *s.* 4 *d.*——3 Ells.

The Question being thus Stated, I reduce the middle Number into Pence, the lowest Name mentioned, by multiplying by 20, and then by 12. This done multiply this last Product by 3. The Product which is 27228, I divide by 86, the first term; the Quote 316 is the Number of Pence (the Name I left the second Number in before I multiplyed by the third) that Answers the Question, which may by Reduction be brought into Shillings and Pounds, all which is done in the following operation of the preceding Question.

If

If 86 Ells cost 37 *l.* 16 *s.* 4 *d.* what cost 3 Ells

```
                 20
              --------
86)27228(316|756
   ------       12    12)316(2(6
                 -------  --------
    142
    ---       9076       76   1 l. 6 s 4 d.
                         ---
    568          3        4   the price of
    ---        -----              3 Ells.
     52      27228
```

Over and above the 1 *l.* 6 *s.* 4 *d.* there is a ſmall remainder, which is ſome Fractional part of a Peny.

The Value of which is found by multiplying the remainder 52 by 4 and dividing by 86, ſo will the Quote be 2 Farthings, and a Fractional part beſides.

The Proof of this Rule.

The Proof of this Rule is almoſt evident from the reaſon of the Anſwer; for if at the rate of 86 Ells for 37 *l.* 16 *s.* 4 *d.* three Ells will coſt 1 *l.* 6 *s.* 4 *d.* then, at the ſame rate, when 3 Ells coſt 1 *l.* 6 *s.* 4 *d.* 86 Ells will coſt 37 *l.* 16 *s.* 4 *d.* therefore 'tis but back ſtating the Queſtion, and ſaying, If 3 Ells coſt 1 *l.* 6 *s.* 4 *d.* what will 86 Ells coſt; here working as before directed you ſhall find 37 *l.* 16 *s.* 4 *d.* the given price

of

of the aforesaid 86 Ells, as you see in the following Operation, which is a sure Proof of the Question.

If 3 Ells cost 1 *l.* 6 *s.* 4 *d.* What will 86 Ells cost?

```
 20      316
----    -----              12
 26       516   3(27228(9076(75(6
 12       86      ----     ---
----     258        22    |67
316     -----      ----   ----
         27176      18     76
            52      ---    --- 37l.16s.
        ------                 4d. An.
         27228                4
```

But here Note that in the preceding Question there remains 52 after you divided the Product of the second and third by the first, which 52 must now in the Proof be added to the Product of the second and third before you divide by the first.

By observing these Directions may all Questions in this Rule be solved, only in some there is required the Addition or Subtraction of two Sums of Money, sometimes before the Question is stated, and sometime not till after the Operation is ended.

For

For Example.

If 97 Dozen of Beavers cost 679 *l.* 19 *s.* 4 *d.* how must I sell one Beaver to gain 15 *l.* 10 *s.* 8 *d.* by the sale of the whole?

Before I state this Question I must add the Money I am to gain, which is 15 *l.* 10 *s.* 8 *d.* to 679 *l.* 19 *s.* 4 *d.* the Money the Beavers cost.

Again in this Question, Bought 1498 Pound of Tabacco which cost 53 *l.* 17 *s.* 8 *d.* and some damage happening to it, I lost 13 *l.* 1 *s.* 2 *d.* by the sale of the whole, the Question is what one Pound was sold for?

Here I must subtract the loss from the prime cost of the Tabacco, and then state the Question with the remainder, by saying, if 1498 Pound cost the remaining Money, what will one Pound cost? These and such like Questions are such as require some small Operation before you state the Question, in order for its Solution.

More Examples.

If I spend 5 *s.* 3 *d.* in one Day, how much is that in one Year? *Answer*, 95 *l.* 16 *s.* 3 *d.*

If an Ounce of Silver cost 4 *s.* 8 *d.* $\frac{1}{2}$, how much will 358 *l.* 19 *s.* 2 *d.* buy? *Answer*, 1524 $\frac{176}{226}$.

If

If 397 Ells of Cloth coſt 86 *l.* 14 *s.* 2 *d.* what coſt one Ell? *Anſ.* 4 *s.* 4 *d.* $\frac{1}{4}$ $\frac{267}{397}$.

If 97 Dozen of Beavers coſt 679 *l.* 19 *s.* 4 *d.* how muſt I ſell one Beaver for to gain 15 *l.* 18 *s.* 4 *d.* by the ſale of the whole? *Anſwer*, 11 *s.* 11 *d.* $\frac{1}{4}$ $\frac{1076}{1164}$.

Bought 1498 Pound of Tabacco which coſt 53 *l.* 17 *s.* 8 *d.* and ſome damage happening to it I loſt 13 *l.* 1 *s.* 2 *d.* by the ſale of the whole, the Queſtion is what one Pound was ſold for? *Anſ.* 6 *d.* $\frac{1}{2}$ $\frac{244}{1498}$.

A Gentleman's daily Expences is 13 *s.* 7 *d.* $\frac{1}{4}$, above which he lays up 150 Nobles Yearly, the Queſtion is what his Eſtate is worth *per Annum*? *Anſ.* 298 *l.* 5 *s.* 6 *d.* $\frac{1}{4}$.

If I buy a piece of Cloth for 37 *l.* 18 *s.* 2 *d.* and I ſell one Ell *Engliſh* for 18 *s.* 3 *d.* I demand how many Yards were in the Piece? *Anſwer*, 51 *y.* 3 *q.* $\frac{111}{219}$.

Beſides theſe there are other Queſtions, ſome of which require two, others three or more Operations of the *Single Rule of Three*, which ſome Authors put under the Title of the *Double Rule of Three Direct*. But becauſe their Solutions depends only upon the *Single Rule of Three*, I therefore thought it moſt proper to place them here; they are as followeth.

A Gentleman's Living is worth 436 *l.* 14 *s.* 6 *d.* *per Annum*; how much muſt he ſpend Daily to lay up Monthly 5 *l.* 18 *s.* 4 *d.* *Anſwer*, 19 *s.* 8 *d.* $\frac{214}{365}$.

A

Is 13 months to ye year

5 : 18 : 4

A Tobacconist delivered 7956 Pound weight of Tobacco in the Roll to be Cut and Dry'd, and when it came home it hold out but 6178 Pound, I demand what is lost in the Pound, and supposing it cost in the Roll 10 *d.* $\frac{1}{4}$, and the cutting 1 *d.* $\frac{1}{2}$, what it now standeth him in? *Answer*, 3 Oz. $\frac{1145}{1989}$. and 389 *l.* 10 *s.* 3 *d.*

A Merchant sent Goods to *Spain*, to the value of 763 *l.* 10 *s.* to have Returns from thence, the $\frac{1}{3}$ in *Spanish* Tobacco at 7 *s.* 9 *d.* the Pound, and the rest in Wine at 14 *l.* 12 *s.* the Tunn; how much of each of these Goods must he receive for Satisfaction? *Answer*, 656 *l.* $\frac{22}{93}$. 34 *Ton.* $\frac{252}{292}$.

There is 180 *l.* 6 *s.* to be divided between three Children, *A* is to have the half of the Money, *B* is to have the third, and *C* to have the fourth part; what must each Child have for his Portion? *Answer*. 83 *l.* 4 *s.* $\frac{14424}{46878}$. 55 *l.* 9 *s.* $\frac{21242}{46878}$. 41 *l.* 14 *s.* $\frac{722}{46878}$.

of 180: 6, makes 195: 6

180: 6

90: 3

60: 2

The Rule of Three Reverse.

BEing so called, because it produceth a Reverse, or Contrary Proportion to the Rule of Three Direct: In which the greater the third Number is, so much the greater will the fourth be; but here the greater the third

Number is so much the lesser will the fourth be.

The Method of Operating in this Rule is quite contrary to that of the Direct; for having stated the Question according to the Precept given in the preceding Rule, work thus, *Multiply the first Term by the second, and divide the Product by the third, the Quote is the Answer to the Question, in the same term you left the middle Number in.*

But before I proceed to the Stating and Operating a Question, I shall shew how to know when a Question is to be Answered by the Direct or Indirect Rule.

If the Nature of the Question be so that *more* require *more*, or *less less*, the *Answer* is found by the Direct Rule.

But if *more* require *less*, or *less more*, the *Answer* is found by the Indirect Rule, and the third Term is the Divisor. *For Example.*

If 6 Sheep cost 10 *l.* then, 'tis evident 12 Sheep will cost 20 *l.* and 3 Sheep will cost 5 *l.* *that is*, the more Sheep the more Money.

But if 6 Men do a piece of Work in 10 Days, then will 12 Men do the said piece in 5 Days, and 3 Men will require 20 Days, *that is* the more Men the less time, and the less Men the more time. This being premised, I shall proceed to give you an Example.

If

If in 796 Days 298 Men finish a piece of Work, In how many Days will 376 Men finish the said piece in?

Men *Days* *Men.*

298 —— 796 —— 376
298

6368
7164
1592

Days

376)237208(630 —— $\frac{328}{376}$ *Answ.*
2256

1160
1128

328

The Proof of this Rule.

The Proof of this Rule is after the same manner with the former, *viz.* by a back stating, saying, If 376 Men do a piece of Work in 630 Days, In what time will 298 Men do the said Work in? Here operating as in the preceding Case, *viz.* by multiplying the first by the second, taking in the remainder, and then dividing by the third, you will find 796 come out for the *Answer*, which is manifestly from what foregoes, a sure proof of the Question.

Here alſo, as in the preceding Rule, in ſome Queſtions there is required the Addition and Subſtraction of Numbers, and in this Rule 'tis commonly after the Operation is ended.

For Example.

A certain piece of Land will Graze 254 Horſes for 137 Days, how many more Horſes muſt I take in to eat up the ſaid Paſture in 38 Days.——— Having ſtated and wrought this Queſtion by the foregoing Rule there will come out 915, the whole number of Horſes the Land will Graze for 38 Days.——If now from 915 you take 254, the remainder is 661, the Horſes that muſt be put in to thoſe already there to eat up the Paſture.—— Theſe, with others of the like Nature, does many times occur.

More Examples.

How much muſt the Penny White Loaf weigh, when Wheat is ſold for 8 *s.* 2 *d.* Bu. if when it weigheth 18 *p-wt.* $\frac{1}{2}$ the Bu. is ſold for 6 *s.* 4 *d.* $\frac{1}{2}$? *Anſwer*, 14 *p-wt.* $\frac{173}{196}$.

If when the Buſhel of Wheat is ſold for 7 *s.* 9 *d.* $\frac{3}{4}$, the Penny White Loaf weigh 13 *p-wt.* what muſt the Buſhel of Wheat be ſold for when the Penny White Loaf weighs 17 *p-wt.* $\frac{3}{4}$? *Anſwer*, 5 *s.* 11 *d.* $\frac{1}{4}$ $\frac{15}{71}$.

If

If when the Days are 13 hours $\frac{3}{4}$ long, a Traveller performs his Journey in 35 Days $\frac{1}{3}$, in how many Days will he perform the said Journey, when the Days are 11 hours $\frac{1}{4}$ long? *Answer*, 43 Days $\frac{15}{71}$.

A Captain is Besieged with 160000 Men, for which he has only Provision for 237 Days, how many of these Men must he disband to make the said Provision last 2 Years and $\frac{1}{2}$? *Answer*, 118329 Men $\frac{610}{910}$.

Suppose 358 Pieces, at 14 *s.* 7 *d.* $\frac{1}{2}$ each was exchanged for 436 Pieces, at what rate was that Piece valued at? *Answer*, 12 *s.*

How much Shalloon of $\frac{1}{2}$ a Yard wide, will Line a Coat, that has 2 Yards $\frac{3}{4}$ of Cloth 7 Quarters wide? *Answ.* 9. y. 3. q. $\frac{1}{2}$.

The Doctrine of Vulgar Fractions.

What a Fraction is, and how Read.

AN *Unite* or *Integer* is one whole thing, as *one Pound*, *one Yard*, *one Gallon*, *one Hour*, &c.

A *Fraction*, or *broken Number*, is a part or parts of a *Unite*, and is represented by two

Numbers set one over another, with a Line between them thus, $\frac{1}{2}$, $\frac{2}{3}$, $\frac{2}{4}$, $\frac{5}{6}$, *&c.* the upper Number is termed the *Numerator*, the lower the *Denominator*, they are read or pronounced thus, $\frac{1}{2}$ *one half*, $\frac{2}{3}$ *two thirds*, $\frac{3}{4}$ *three fourths*, and so of any other, naming the Numerator first, and the Denominator last; the Denominator shewing the parts into which the Unite is broke, and the Numerator the part (or parts) of the Denominator that is to be taken or used.

Of the several kinds of Fractions.

Of Fractions, or broken Numbers, there be four kinds, viz. *Proper*, *Improper*, *Mixt*, and *Compound*.

A *Proper Fraction* is that whose Numerator is less than the Denominator, as $\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{5}$, $\frac{4}{7}$, *&c.*

An *Improper Fraction* has its Numerator greater than (or at least equal to) the Denominator, as $\frac{4}{3}$, $\frac{5}{2}$, $\frac{6}{6}$, $\frac{4}{4}$, *&c.*

Mixt, are whole Numbers and Fractions set together thus, $2\frac{1}{3}$, $3\frac{5}{8}$, $7\frac{3}{4}$, *&c.*

Compound Fractions are known by having the word [*of*] betwixt them, and are written thus, $\frac{2}{3}$ of $\frac{1}{4}$, also $\frac{1}{4}$ of $\frac{5}{6}$ of $\frac{7}{8}$, they are likewise called *Fractions* of *Fractions*.

Now before we can pass to the Rules of *Addition*, *Substraction*, *Multiplication*, and *Division*, they must be prepared and made

fit

fit for ſuch Operation, which preparation is performed by *Reduction*, of which there are five kinds, as follows.

Reduction the First.

TEacheth to reduce a whole or mixt Number into a Fraction, which Fraction ſhall be equal in value to the ſaid whole or mixt Number; *and contrary*, It teacheth to turn a Fraction into its equivalent whole or mixt Number.

Rule 1*ſt*. If it be a whole Number, then multiply it by the aſſign'd Denominator, and ſet the Product thereof for a Numerator over the ſaid Denominator; ſo ſhall this Fraction be equal to the given whole Number.

Example, Reduce 7 to a Fraction, whoſe Denominator ſhall be 4.

7 whole Number.
4

28 Numerator required.

ſo that $7 = \frac{28}{4}$.

Note. Theſe two Lines $=$ is the ſign of Equality, as $7 = \frac{28}{4}$ ſhews that 7 is equal to 28 Fourths.

 More

More Examples.

$$\text{Reduce}\left\{\begin{array}{c}5\\8\\9\end{array}\right\}\begin{array}{l}\text{to a Fraction}\\\text{whose Deno-}\\\text{minator is}\end{array}\left\{\begin{array}{c}4\\6\\7\end{array}\right\}\textit{Answer}\ \begin{array}{c}\frac{20}{4}\\\frac{48}{6}\\\frac{63}{7}\end{array}\Big\}$$

Rule 2d. If a mixt Quantity is given to be reduced, then multiply the whole Number by the Denominator of the Fraction, adding thereto the Numerator, the Summ shall be a new Numerator, which if set over the old Denominator will give a Fraction of the same value with the proposed mixt Quantity.

Example, Reduce $2\frac{3}{4}$ to a Fraction.

$2\frac{3}{4}$

4

11 new Numerator, so that $2\frac{3}{4} = \frac{11}{4}$.

More Examples.

$$\text{Reduce}\left\{\begin{array}{c}3\frac{5}{7}\\6\frac{2}{3}\\5\frac{4}{9}\end{array}\right\}\text{to a Fraction.}\Big\}\ \textit{Ans.}\left\{\begin{array}{c}\frac{26}{7}\\\frac{20}{3}\\\frac{49}{9}\end{array}\right\}$$

Rule 3d. If an Improper Fraction is to be reduced into its equivalent whole or mixt Number; then divide the Numerator by the Denominator, so will the Quote give a whole Number equal to the Fraction given.

Example

Example 1. Reduce $\frac{28}{4}$ into its equivalent whole Number.

4)28(7 ſo that 7 is the whole Number required.

More Examples.

Reduce	$\frac{36}{4}$ $\frac{54}{9}$ $\frac{68}{4}$	to its Equivalent whole Number.	*Anſwer*	9 6 17

If after Dividing any thing remain ſet it for a Numerator over the Fractions Denominator, and join the ſaid Fraction to the Quote.

Example 2. Reduce $\frac{11}{4}$ into its Equivalent mixt Number.

4)11($2\frac{3}{4}$ mixt Numbers equal.
  8
———
  3
———

More Examples.

Reduce	$\frac{27}{5}$ $\frac{39}{8}$ $\frac{14}{4}$	to its Equivalent mixt Number.	*Anſwer*	$5\frac{2}{5}$ $4\frac{7}{8}$ $3\frac{2}{4}$

The proof of any of theſe Caſes is performed by a contrary Operation.

This

This *Reduction* is absolutely necessary, for there is no working with whole Numbers and Fractions, till the whole Numbers are made Fractions.

Reduction the Second.

TEacheth to reduce a Compound Fraction to a simple one, which shall have the same value.

Rule, Multiply all the Denominators one into another continually, and set the Product for a Denominator. Then multiply all the Numerators one into another, and set the Product for a Numerator over the former Denominator, the Fraction thus formed is equivalent to the given Compound Fraction.

Example, Reduce $\frac{3}{4}$ of $\frac{8}{9}$ of $\frac{9}{12}$ to a simple Fraction.

3 Numer. 1*st.*	4 Denom. 1*st.*
8 Numer. 2*d.*	9 Denom. 2*d.*
24	36
9 Numer. 3*d.*	12 Denom. 3*d.*
216 Num. sought.	432 Denom. sought.

so that $\frac{3}{4}$ of $\frac{8}{9}$ of $\frac{9}{12} = \frac{216}{432}$.

The

The proof of this Operation is thus. Multiply the Numerator of the ſimple Fraction into all the Denominators of the Compound; Then the Denominator of the Simple into all the Numerators of the Compound. If the two Products are equal the Work is right, elſe not.

$$\begin{array}{r}216\\12\\\hline 2592\\9\\\hline 23328\\4\\\hline 93312\\\hline\end{array}\qquad\begin{array}{r}432\\9\\\hline 3888\\8\\\hline 31104\\3\\\hline 93312\\\hline\end{array}$$

More Examples.

Reduce $\left\{\begin{array}{l}\frac{4}{5}\text{ of }\frac{5}{6}\text{ of }\frac{8}{9}\\\frac{3}{6}\text{ of }\frac{6}{7}\text{ of }\frac{7}{9}\end{array}\right\}$ to a ſimple Fraction. $\left\{A.\left\{\begin{array}{l}\frac{160}{270}\\\frac{126}{378}\end{array}\right\}\right.$ 270

378

This *Reduction* is likewiſe abſolutely neceſſary, for there is no Working with Compound Fractions and others, till the ſaid Compound Fractions, are reduced to Simple.

Reduction

Reduction the Third.

TEacheth to Abreviate a Fraction, that is to reduce it to its lowest Terms, yet still keeping the same value.

Rule 1. Divide the Numerator and Denominator (if they be both even) by 2, 4, 6, 8, *&c.* If the Numer. and Denom. be one even, and the other odd, or both odd, try some odd Number, as 3, 5, 7, 9, *&c.* repeat this Division as often as you can, so shall the last Quotient of the Numerator be a new Numerator, and the last Quote of the Denominator a new Denominator.

Exam. Reduce $\frac{216}{432}$ into its lowest Terms.

$$\begin{array}{c|c|c|c|c} 4 & 2 & 3 & 9 & \\ \frac{216}{432} & \frac{54}{108} & \frac{27}{54} & \frac{9}{18} & \frac{1}{2} \end{array}$$ so that $\frac{216}{432} = \frac{1}{2}$.

But the general way of reducing a Fraction to its lowest Terms is to find a *common Measurer*, that is, the greatest Number which will divide both Numerator and Denominator without a remainder, by which means a Fraction is brought to its lowest Terms at the first Operation: For finding of which the Rule is.

Rule

Rule 2. Divide the Denominator by the Numerator, if any thing remain, by it divide the former Divisor, and if after this Division any thing remain, divide the last Divisor by it; Proceed thus till nothing remain, so shall the last Divisor be the greatest *common Measurer*, and is a Number that will divide both Numerator and Denominator without a remainder, and so reduce a Fraction to its lowest Terms at the first Operation; but if after all the Divisions are ended there remains 1, then is such Fraction in its lowest Terms already.

Exam. Reduce $\frac{4056}{13104}$ to its lowest Terms.

```
4056)13104(3        936)4056(4
      936                312
```

```
312)936(3
```

So that 312 is the greatest Common Measurer or Number that will divide the Numerator and Denominator without a Remainder, *See the work.*

$$312)\frac{4056}{13104}(\frac{13}{42}$$

so that $\frac{13}{42} = \frac{4056}{13104}$.

The

The proof of this Operation is thus, multiply the Numerator of the given Fraction by the Denominator of that 'tis reduc'd to, and the Numerator of that 'tis reduc'd to by the Denominator of the given Fraction; if these two Products are equal, the Work is right, else not.

170352

But $\left\{ \begin{matrix} 4056 \\ 13104 \end{matrix} \right\}$ multiply'd by $\left\{ \begin{matrix} 42 \\ 13 \end{matrix} \right\}$ are equal.

More Examples.

[redacted]

$\frac{216}{378}$

Reduce $\left\{ \begin{matrix} \frac{160}{170} \\ \frac{216}{678} \end{matrix} \right\}$ to their lowest Terms. $\left\{ \textit{Ans.} \left\{ \begin{matrix} \frac{16}{17} \\ \frac{4}{7} \end{matrix} \right\} \right.$ [redacted]

$\frac{216}{378}$

[redacted]

This *Reduction* is also very useful, for by it Fractions that are express'd by great Numbers, are made to be express'd by smaller, by which their true value is the more readier known.

[redacted]

Reduction the Fourth.

TEacheth how to bring Fractions of divers Denominations into Fractions of one Denomination, yet still retaining the same value.

Rule, Multiply all the Denominators continually one into another, and set the Product

I judge y above number wrong printed it should be $\frac{216}{378}$ wch makes $\frac{4}{7}$

for $\left\{ \begin{matrix} 216 \\ 378 \end{matrix} \right\}$ multiplyed by $\left\{ \begin{matrix} 7 \\ 4 \end{matrix} \right\}$ are equal

duct thereof for a new Denominator; then multiply the Numerator of the first Fraction into all the Denominators except its own, the Product is the Numerator of the first Fraction, and must be set over the Denominator before found; so likewise for the second Fraction you must multiply its Numerator into all the Denominators except its own, the Product is the Numerator of the second Fraction. Proceed thus with the rest of the Numerators, that is, multiply each Numerator by all the Denominators except its own, setting the several Products for new Numerators over the Common Denominator first found, so shall these new Fractions be of one Denomination and equivalent to the former.

Example, Reduce $\frac{2}{3}$, $\frac{4}{7}$, $\frac{5}{6}$, into one Denomination.

3 *Denom. 1st.*	4 *Numer. 2d.*
7 *Denom. 2d.*	3 *Denom. 1st.*
21	12
6 *Denom. 3d.*	6 *Denom. 3d.*
126 *Common Denom.*	72 *New Numer. 2d.*
2 *Numer. 1st.*	5 *Numer. 3d.*
7 *Denom. 2d.*	7 *Denom. 2d.*
14	35

Denom.

Brought over 3-14

6 *Denom.* 3*d.* 3 *Denom.* 1*st.*

84 *New Numer.* 1*st.* 105 *New Numer.* 3*d.*

So that $\frac{2}{3} = \frac{84}{126}$ and $\frac{4}{7} = \frac{72}{126}$ and $\frac{5}{6} = \frac{105}{126}$

The Proof of this Reduction is as in the last, that is, you must multiply the Numerator of the Fraction given, by the Denominator of that 'tis reduc'd to; so also the the Denominator of the Fraction given by the Numerator of the aforesaid Fraction, then if the two Products are equal the Work is right, else not. *The Operation is as followeth.*

By the last $\frac{2}{3} = \frac{84}{126}$ and therefore 84 multiply'd by 3 is equal to 126 multiply'd by 2.

More Examples.

$\frac{2}{5} : \frac{1}{7} : \frac{5}{6}$

R. $\left\{ \begin{array}{l} \frac{2}{5}, \frac{1}{7}, \frac{5}{6}, \\ \frac{3}{7}, \frac{1}{2}, \frac{5}{8}, \end{array} \right\}$ to one Denom. $\left\{ A. \left\{ \begin{array}{l} \frac{84}{210}, \frac{30}{210}, \frac{175}{210}, \\ \frac{48}{112}, \frac{56}{112}, \frac{70}{112}, \end{array} \right\} \right.$

112, 112, 112

$\frac{3}{7} : \frac{1}{2} : \frac{5}{8}$

Notes, 1*st.* If mixt Numbers are given thus to be reduced, reduce only the Fractional Parts.

2*d.* If Compound Fractions are to be reduced to one Denominator they must first be brought to simple ones by *Reduction* 2,

This

This *Reduction* is alſo abſolutely neceſſary, for before Fractions are brought to the ſame Denomination, they can neither be added nor ſubſtracted.

Reduction the Fifth

TEacheth to change a Fraction into another equal in value, that ſhall have any aſign'd Denominator.

Rule. Multiply the Numerator of the given Fraction by the aſſign'd Denominator, and the Product divide by the old Denominator, the Quote is the Numerator to the aſſign'd Denominator.

Exa. Reduce $\frac{84}{126}$ into a Fraction, whoſe Denoninator ſhall be 3.

$$
\begin{array}{rl}
84 & \textit{Numerator,} \\
3 & \textit{Denominator assign'd.} \\
\hline
126)252(2 & \textit{New Numerator.} \\
252 & \\
\hline
\end{array}
$$

So that $\frac{84}{126} = \frac{2}{3}$.

The Proof of this Reduction is as before, that is, you muſt multiply the Numerator of the given Fraction by the Denominator of that it's reduc'd to ; *and contrary.* If

 then

27
8
216
9
24
27

then the Products are equal the Work is right, else not.

w:ch makes

More Examples.

24/27

Reduce $\left\{\begin{matrix}\frac{8}{9}\\ \frac{5}{12}\end{matrix}\right\}$ to a Fraction whose Den. is $\left\{\begin{matrix}27\\ 36\end{matrix}\right\}$ Ans. $\left\{\begin{matrix}\frac{24}{27}\\ \frac{15}{36}\end{matrix}\right\}$

15/36

36
5
180
12
15
36

Note. If a Compound Fraction is thus to be reduc'd. Turn it to a Simple, by *Reduction* 2, and then work as the preceding Rule directs.

This *Reduction* is the most useful of all others, for by it the value of any Fraction is found in the known Parts of *Coyn, Weight, Time, &c.* and contrary, that is, it teacheth to turn any part of *Coyn, Weight, Time,* &c. into a Fraction, which because it is one of the chiefest things in Fractions, I shall enlarge farther upon it.

In order to be as clear as possible in this Matter, I must again tell you that this Reduction teaches to change a Fraction to another that shall have any assign'd Denominator, yet still keeping the same Value; so that if it were required to reduce $\frac{3}{5}$ to another whose Denominator shall be 20, and suppose the $\frac{3}{5}$ to be $\frac{3}{5}$ of a Pound Sterling; here then 'tis evident, that if I know how many twentieths $\frac{3}{5}$ is, I know how many Shillings 'tis; because one Shilling is the $\frac{1}{20}$ of a Pound. Again suppose the $\frac{3}{5}$ of

3/5 of £, is 12s,

5/8

 $\frac{5}{8}$ of 1, 7 $\frac{1}{2}$

of a Shilling was required, if then I change this Fraction to another, that ſhall have 12 for its Denominator, 'tis evident I ſhall know how many Pence 'tis, becauſe one Penny is the 12th of a Shilling. The like is to be underſtood of *Weight*, *Time*, &c. and therefore to find the value of any Fraction in the known parts of *Coyn*, *Weight*, *Time*, &c. take the following Direction.

Multiply the Numerator by the parts of the next inferiour Denomination, that are equal to an Uuite that the Fraction gives the parts of. The Product divide by the Denominator, the Quote gives the value in the parts you multiply'd by; if after this Diviſion any thing remain, multiply it by the next inferiour Denomination, dividing the Product by the Denominator as before. Thus proceed till you can bring it no lower, ſo will the ſeveral Quotients give the requir'd value of the Fraction, and if any thing remain, then ſet it for a Numerator over the former Denominator.

y like rule in page (104)

Example, 1*ſt*. What's the $\frac{6}{8}$ of a Shilling?

$$\begin{array}{r} 6 \\ 12 \\ \hline 8)72(9 \\ \hline \end{array}$$

So that 9 *d*. is the $\frac{6}{8}$ of a Shilling.

vide Example in page (105)

Example 2d. What's the $\frac{17}{19}$ of a Pound Sterling?

```
        17
        20
      ----
19)340(17 Shillings
     19
     ---
     150
     133
     ---
      17 Remainder 1st.
      12
     ---
19(204(10 Pence
     19
     ---
      14 Reminder 2d.
       4
     ---
19)56(2 Farthings
    38
    ---
    18 Remainder 3d.
```

19)56(2
38
18 Rem

So that the $\frac{17}{19}$ of a Pound Sterling is 17 *s.* 10 *d.* $\frac{1}{2}$ and $\frac{18}{19}$ of a Farthing.

Example 3d. What's the $\frac{5}{9}$ of a Pound *Haverdupoize* Weight?

5
16

9)80(8 *Ounces*

8 1*st. Remainder*
16

9(128(14 *Drams*

38

2

So that $\frac{5}{9}$ of a Pound *Haverdupoize* is 8 Ounces 14 Drams $\frac{2}{9}$.

After this Method may the value of any Fraction be found, whether it be of *Coyn*, *Weight*, *Time*, *Liquor Meaſure*, *Long Meaſure*, &c. and given in known and familiar Terms, as in the Second Example, where the value of $\frac{17}{19}$ of a Pound *Sterling* was requir'd: I anſwer, that it's 17 Shillings and 10 Pence half Penny, and $\frac{18}{19}$ of a Farthing. So likewiſe in the Third Example, the $\frac{5}{9}$ of of a Pound *Haverdupoize* is found to be 8 Ounces, 14 Drams, and $\frac{2}{9}$ of a Dram.

If you would turn any part of *Coyn*, *Time*, *Weight*, &c. into a Fraction, 'tis but the converſe of the former Rule, and therefore may be eaſily effected from a little Conſideration of what precedes. For if you do but conſider

that one Shilling is the $\frac{1}{20}$ of a Pound ſterling, and a Penny the $\frac{1}{12}$ of a Shilling, or the $\frac{1}{12}$ of $\frac{1}{20}$ of a Pound; as alſo a Farthing the $\frac{1}{4}$ of Penny, or the $\frac{1}{4}$ of $\frac{1}{12}$ of $\frac{1}{20}$ of a Pound, the Names of a *Shilling*, a *Penny*, and a *Farthing*, being only Denominations given for the Vulgar to know them by. The Univerſal way of expreſſing them being to call a Shilling the $\frac{1}{20}$ of a Pound, and a Penny the $\frac{1}{12}$ of a Shilling, alſo a Farthing the $\frac{1}{4}$ of a Penny, and this way of expreſſing them (ſuppoſing the value of the Pound known) would be Intelligible to all Nations that have the knowledge of Numbers. So that if it were required to know what part of a Shilling 9 *d.* is, I Anſwer $\frac{9}{12}$, or when abreviated $\frac{3}{4}$. In like manner if it is requir'd to know what part of a Pound a Penny is, here I muſt conſider that one Penny is the $\frac{1}{12}$ of $\frac{1}{20}$ of a Pound Sterling, and therefore by Reduction 2*d.* is $\frac{1}{240}$ of a Pound. Laſtly if it be required to know what part of a Pound 2 *s.* 9 *d.* is, I conſider it thus, 2 *s.* 9*d.* is 2 *s.* $\frac{9}{12}$, and when reduced to an improper Fraction $\frac{33}{12}$ of a Fraction; ſo the Queſtion will be, what's the $\frac{33}{12}$ of $\frac{1}{20}$ of a Pound Sterling, (the $\frac{33}{12}$ being only parts of a Shilling) working therefore by Reduction 2*d.* you ſhall find that 2 *s.* 9 *d.* is $\frac{33}{240}$ of a Pound Sterling.

s. d.
2-9, is 33
parts, of
240 parts,
of one £

Addition

d
240, pence, is 20,

4
5
20
11
220 - deno

Addition of Fractions.

RUle. If they have not alike Denomination they must all be reduc'd to the same, then add the Numerators together, and set the Sum for a new Numerator over the common Denominator, it is the Sum required.

165, $\frac{3}{4}$ of 220
88, is $\frac{2}{5}$ of 220
140, is $\frac{7}{11}$ of 220

55 44 20

Example, Add $\frac{3}{4}$ and $\frac{2}{5}$ and $\frac{7}{11}$ together.

Reduc'd they become $\frac{165}{220}$, $\frac{88}{220}$, $\frac{140}{220}$.

393

The Sum $\frac{393}{220}$ or 1 $\frac{173}{220}$

$$\begin{array}{r} 165 \\ 88 \\ 140 \\ \hline 393 \end{array}$$

Observe, If the Fraction, that is the Sum of those two given, happen to be an improper Fraction; then by *Reduction 1st. Rule 3d.* reduce it into its equivalent, whole or mixt Number, as in the last Example.

The Proof of Addition is best done by a careful Reduction, and collecting them together.

More Examples.

What's the Sum of $\left\{\begin{array}{l} \frac{3}{5} \\ \frac{4}{9} \end{array}\right.$ *Answ.* $\frac{47}{43}$.

$\left.\begin{array}{l} \frac{3}{5} \\ \frac{4}{9} \end{array}\right\} \frac{47}{43}$

What the Sum of $\left\{\begin{array}{l} \frac{6}{9} \\ \frac{3}{5} \end{array}\right.$ *Answ.* $\frac{17}{45}$, or 1 $\frac{4}{15}$.

F 4 Note,

$\left.\begin{array}{l} \frac{6}{9} \\ \frac{3}{5} \end{array}\right\} \frac{57}{45}$ or 1: $\frac{4}{5}$.

Note, 1. If you are to add mixt Numbers, add only the Fractional parts being first reduced to the same Denomination.

2. If you are to add Compound Fractions, reduce them first to Simple, and then to a Common Denominator.

3. If the Fractions to be added are not parts of the same whole (though of the same kind) as thus, the sum of $\frac{2}{3}$ of a Shilling, and $\frac{1}{5}$ of a Pound Sterling is required; here they are not only of different Denominations, but parts of different wholes, and therefore more properly worded thus.

What's the Sum of $\frac{1}{5}$ and $\frac{2}{3}$ of $\frac{1}{20}$ of a Pound Sterling? *Answer*, $\frac{190}{300}$.

Substraction of Vulgar Fractions.

THE *Rules* deliver'd for reducing and making of Fractions fit for Addition, are in all Respects and Cases to be observ'd in Substraction, so that whether they are *Simple*, *Mixt* or *Compound*, they must be reduc'd to a common Denominator.

Then take the Numerator of the *Substractor*, or Fraction to be substracted from the Numerator of the *Substrahend* or Fraction, from which we are to substract, and set the remainder over the common Denominator

$\begin{array}{r} 29 \\ 3 \\ \hline 87 \end{array}$ $\begin{array}{r} 21 \\ 3 \\ \hline 63 \end{array}$

nator, so is this new Fraction the remainder or difference sought.

Exam. From $1\frac{8}{21}$ or $\frac{29}{21}$ Substract $\frac{2}{3}$.

Reduc'd to a common Denominator they stand thus, $\left\{\begin{array}{l} \frac{87}{63} \\ \frac{42}{63} \end{array}\right.$

Remainder $\frac{45}{63}$ or $\frac{5}{7}$.

$\begin{array}{r} 21 \\ 2 \\ \hline 42 \end{array}$

$\begin{array}{r} 87 \\ 42 \\ \hline 45 \end{array}$

The Proof of this is performed as in common Substraction, *viz.* By adding the Remainder to the quantity taken away, the Sum is the quantity first propos'd.

More Examples.

From $\frac{38}{45}$ take $\frac{4}{9}$ *Answer* $\frac{1}{5}$. $\frac{1}{5}$

From $1\frac{4}{15}$ or $\frac{19}{15}$ Substract $\frac{3}{5}$ *Ans.* $\frac{2}{3}$.

$\frac{3}{5}$ $\frac{2}{3}$

Multiplication of Vulgar Fractions.

IF they be Simple Fractions to be multiply'd, then Multiply the two Numerators together for a Numerator, and the two Denominators for a Denominator, the Fraction form'd by these two Numbers is the Product requir'd.

Exam-

Example, Multiply $\frac{5}{8}$ by $\frac{3}{4}$. $\frac{3}{4}$

5 *Numerators.*	8 *Denominators.*
3	4
15	32

$\frac{15}{32}$ so that $\frac{15}{32}$ is the Product required.

The best Proof of Multiplication is by Division, and therefore I shall refer it till I come to treat of the like in Division.

More Examples.

Multiply $\frac{7}{9}$ by $\frac{8}{11}$ *Answer* $\frac{56}{99}$
Multiply $\frac{4}{9}$ by $\frac{13}{17}$ *Answer* $\frac{52}{153}$

Note 1. If mixt Numbers are to be multiplied, reduce them into improper Fractions by *Reduction* 1st. *Rule* 2d. and then Multiply them together.

Exam. Multiply $3\frac{1}{2}$ by $3\frac{1}{2}$, or $\frac{7}{2}$ by $\frac{7}{2}$ it gives $\frac{49}{4}$ or $12\frac{1}{4}$. $\frac{7}{2}$

From this 'tis evident, how to Multiply any Summ of Money by any Summ of Money; suppose 4 *s.* 6 *d.* by 3 *s.* 4 *d.* that is $4\frac{6}{12}$ by $3\frac{4}{12}$, or $\frac{54}{12}$ by $\frac{40}{12}$ which is $\frac{2160}{144}$, or just 15 Shillings.

2. If they be Compound Fractions, reduce them to Simple ones.

3. If a whole Number is to be multiplied by a Fraction, then make the whole Number an improper Fraction by putting 1 under it.

Division of Vulgar Fractions.

IF the Dividend and Divisor be both Simple Fractions, then Multiply the Numerator of the Dividend by the Denominator of the Divisor, and set the Product for a Numerator. Multiply also the Denominator of the Dividend by the Numerator of the Divisor, and take the Product for a Denominator, the Fraction thus formed is the Quote.

Example, Divide $\frac{15}{32}$ by $\frac{3}{4}$

$\frac{3}{4}$)$\frac{15}{32}$ ($\frac{60}{96}$ or $\frac{5}{8}$ $\frac{5}{8}$

Here (as in whole Numbers) the Proof of Division is by Multiplication, as well as that of Multiplication by Division; and therefore, First, To prove Multiplication 'tis but dividing the Product of two Fractions by one of them, and the Quote will be the other. For *Example*, The Product of $\frac{5}{8}$ by $\frac{3}{4}$ is $\frac{15}{32}$, so that divide $\frac{15}{32}$ by $\frac{3}{4}$ the Quote is $\frac{60}{96}$ which abreviated is $\frac{5}{8}$. Secondly, To prove

prove Division, Multiply the Quote of any two Fractions by the Divisor, and the Quote will be the Dividend, for the Quote of $\frac{15}{32}$ by $\frac{3}{4}$ is $\frac{60}{96}$; Multiply therefore $\frac{60}{96}$ by $\frac{3}{4}$ the Product is $\frac{180}{384}$, which abreviated makes $\frac{15}{32}$ the Dividend.

More Examples.

Divide $\frac{56}{99}$ by $\frac{8}{11}$ *Answ.* $\frac{7}{9}$

Divide $\frac{52}{153}$ by $\frac{4}{9}$ *Answ.* $\frac{13}{17}$.

Note 1. If either Dividend, Divisor, or both, be whole or mixt Numbers, Reduce them to improper Fractions by *Reduction* 1st, *Rule* 1 or 2, and then divide according to the preceding Rule.

2. If they be Compound Fractions, reduce them to Simple ones by *Reduction* 2d.

The Rule of Three Direct in Fractions.

THE Directions given for stating and working a Question in the Rule of Three in whole Numbers, holds also in this of Fractions: So that having stated the Question as is there directed, 'tis but Multiplying

tiplying the Fractions in the Second and Third Place together, and dividing the Product by the First, according to the preceding Rules given for Multiplying and Dividing of Fractions, the *Quotient* is the Answer to the Question.

Example, If $\frac{2}{3}$ of a Yard of Cloth cost $\frac{5}{7}$ of a Pound, What cost $\frac{7}{8}$ of a Yard at that Rate?

If $\frac{2}{3}$ ——— $\frac{5}{7}$ ——— $\frac{7}{8}$

$\frac{35}{56}$

$\frac{2}{3}$) $\frac{35}{56}$ ($\frac{105}{112}$ of a Pound, for *Answer*.

The Proof of this Rule is by a back stateing the Question, saying,

If $\frac{7}{8}$ ——— $\frac{105}{112}$ ——— $\frac{2}{3}$

$\frac{210}{336}$

$\frac{7}{8}$) $\frac{210}{336}$ ($\frac{1680}{2352}$ or $\frac{5}{7}$ for *Answ.*

Here operating as before directed, you see the Answer is $\frac{5}{7}$, which is right, and sure proof of the Question.

More Examples.

If $\frac{8}{9}$ of a Pound *Troy* cost $\frac{5}{7}$ of a Guinea at 22 *s.* What shall $\frac{9}{11}$ of a Pound cost? *Ans.* $\frac{405}{616}$ or 14 *s.* 5 *d.* $\frac{1}{2}$ $\frac{22}{77}$.

If $\frac{4}{5}$ of an Ell *Flemish* cost $\frac{3}{7}$ of an Noble, What will $\frac{14}{15}$ of an Noble buy? *Answ.* $\frac{392}{225}$ or $1\frac{167}{225}$ Noble.

If

If $\frac{7}{12}$ of an Hundred weight cost 34 *s.* $\frac{4}{7}$ What will 19 C. $\frac{3}{4}$ cost? *Answ.* $\frac{453144}{392}$ or 57 *l.* 15 *s.* $\frac{384}{392}$.

Notes 1. If there be mixt Numbers reduce them to improper Fractions.

2. If any of the given Fractions be Compound, they must be reduc'd to Simple Fractions by *Reduction* 2d.

The Rule of Three Reverse in Fractions.

HERE also, as in that of whole Numbers, you are to Multiply the second Term by the first, divide the Product by the third, and the Quotient answers the Question.

Exam. If $\frac{2}{3}$ of a Yard of Cloth that is Yard broad will make a Garment, how much of 3 Yards wide will make the said Garment.

If 1 ——— $\frac{2}{3}$ ——— 3

1 by $\frac{2}{3}$ is $\frac{2}{3}$

$\frac{3}{1}$) $\frac{2}{3}$ ($\frac{2}{9}$ *Answer.*

The Proof of this is obtain'd as was that of the laſt, *viz.* By a back ſtating of the Queſtion, ſaying,

If 3 require $\frac{2}{9}$, what will 1
$\frac{3}{1}$ by $\frac{2}{9}$ $\frac{6}{9}$
$\frac{1}{1}$)$\frac{6}{9}$($\frac{6}{9}$ or $\frac{2}{3}$

More Examples.

If 54 Men build a Houſe in 38 Days, How many Men will build it in 11 Days $\frac{5}{6}$? *Anſwer* 176$\frac{96}{213}$ Men.

$\frac{5}{6}$ Lent $\frac{1}{8}$ of a Pound for $\frac{2}{3}$ of a Year, $\frac{2}{3}$
How much ought to be Lent me again for 2 Years, that I may not loſe nor gain thereby? *Anſwer* $\frac{1}{24}$.

If when the Buſhel of Wheat is Sold for 5 $\frac{2}{3}$ Shillings, the Penny Loaf weighs $7\frac{2}{4}$ Ounces, What muſt it weigh when the Bu-Buſhel is Sold for $6\frac{4}{7}$ Shillings, *Anſwer*, $6\frac{3}{5}\frac{77}{52}$ Ounces.

A Collection of Queſtions to Exerciſe the Rules of Vulgar Fractions.

Note, That for the more eaſier and readier Solution of the following Queſtions I have incerted by what Rules each Queſtion is to be wrought.

By

By Reduction, Second.

What part of a Pound Sterling is $\frac{2}{3}$ of $\frac{5}{9}$? *Answer* $\frac{10}{27}$.

$\frac{2}{3}$ of $\frac{5}{9}$

A Merchant has $\frac{2}{3}$ of $\frac{1}{4}$ of a Coal-Mine, What part is that of the whole? *Answ.* $\frac{2}{12}$.

By Reduction, Fifth.

$\frac{2}{12}$

$\frac{2}{2}$ $\frac{3}{5}$ $\frac{2}{2}$

What's $\frac{2}{3}$ of 17 Shillings? *Answ.* 11 *s.* 4 *d.*
What's $\frac{3}{5}$ of a Dollar at 4 *s.* 2 *d.* *Answer* 2 *s.* 6 *d.*

By Reduction Second and Fifth.

What's the $\frac{5}{7}$ of $\frac{2}{5}$ of a Guinea at 21 *s.* 2 *d.* *Ans.* 6 *s.* $\frac{1}{2}$ *q* $\frac{2}{7}$.
What's the $\frac{7}{9}$ of 5 Pounds? *Answer* 3 *l.* 17 *s.* 9 *d.* $\frac{1}{4}$ *q* $\frac{1}{3}$.
What's the $\frac{2}{3}$ of $\frac{1}{2}$ a Mark? *Answer* 4 *s.* 5 *d.* $\frac{1}{4}$ *q* $\frac{1}{3}$.
What's the $\frac{2}{5}$ of $\frac{1}{2}$ of $\frac{1}{4}$ of 1 Pound, 3 Ounces, 2 Penny-weight *Troy*? *Answer* 15 Penny-weight 2 Grains $\frac{16}{40}$.

By Reduction First, Second and Fifth.

$\frac{3}{7}$

What's the $\frac{3}{7}$ of $8\frac{1}{2}$ Ounces *Averdupoize* weight? *Answer* 3 Ounces 10 Drams $\frac{2}{7}$.
What's $\frac{5}{8}$ of 13 *d.* $\frac{1}{2}$? *Ans.* 8 *d.* 0 *q.* $\frac{6}{8}$.

What's

What's $\frac{7}{9}$ of 15 Days 3 Hours? *Answer*, 11 *d.* 16 *h.* 20 *m.*

By Reduction First, Fourth, and Addition.

What Quantity is that from which if I take $3\frac{5}{7}$ the remainder shall be $1\frac{2}{5}$? *Answer*, 5 and $\frac{4}{35}$. $1\frac{2}{5}$

By Reduction First, Fourth and Substraction.

What Quantity is that to which if I add $3\frac{5}{7}$ the sum shall be $5\frac{4}{35}$? *Answ.* 1 and $\frac{2}{5}$. $\frac{2}{5}$

By Reduction Second, Fourth and Addition.

What Quantity is that from which if I take $\frac{1}{2}$ of $\frac{5}{9}$ the remainder shall be $\frac{2}{7}$ of 5? *Answer*, 1 $\frac{89}{126}$.

A Merchant has $\frac{3}{16}$ and $\frac{1}{2}$ of $\frac{1}{4}$ of a Ship, what part is that of the whole? *Answer*, $\frac{40}{128}$ or $\frac{5}{16}$.

Another Person has $\frac{1}{5}$ of $\frac{1}{8}$ and $\frac{1}{11}$ of $\frac{2}{3}$ of the share in the Cargo of a Ship, what part is that of the whole? *Ans.* $\frac{113}{1320}$.

By Reduction Second, Fourth and Substraction.

What Quantity is that to which if I add $\frac{1}{5}$ of $\frac{7}{9}$ the sum will be 1 $\frac{89}{126}$? *Ans.* 1 $\frac{347}{630}$.

A Merchant bought $\frac{2}{3}$ of $\frac{3}{4}$ of a Ship, another buys $\frac{3}{8}$ of $\frac{4}{5}$, the Question is whe- $\frac{3}{8}$ of $\frac{4}{5}$

G

the-

ther their Parts were equal, and if not, which had the bigest of the two? *Answ. The first Merchant by* $\frac{1}{5}$.

By Reduction Second, Fourth, Addition and Reduction Fifth.

How much is $\frac{2}{3}$ of $\frac{5}{6}$ and $\frac{3}{4}$ of $\frac{1}{2}$ of a *Jacobus* at 25 *s.*? *Ans.* 1 *l.* 3 *s.* 3 *d.* $\frac{0}{4}$ $\frac{2}{3}$.

How much is $\frac{1}{2}$ of $\frac{2}{3}$ and $\frac{7}{8}$ of $\frac{9}{10}$ of a Hundred weight *Averdupoize*? *Answer*, 1 *c.* 0 *q.* 13 *p.* $\frac{8}{15}$.

By Reduction the Fourth, Addition and Substraction.

What's the difference betwix the sum of $\frac{1}{8}$, $\frac{1}{3}$, $\frac{1}{4}$ and a Unite? *Ans.* $\frac{1}{12}$.

By Reduction First, Multiplication and Reduction Fifth.

What's the Product of 3 *s.* 6 *d.* by 3 *s.* 6 *d.* here you are to consider that 6 *d.* is some part of a Shilling, and therefore the Question more rightly propos'd is, What's the Product of $3\frac{1}{2}$ by $3\frac{1}{2}$? *Answer*, $\frac{49}{12}$ or 12 *s.* $\frac{1}{4}$.

s d
12 : 3 —

Again, what's the Product of 3 *l.* 19 *s.* 11 *d.* by 3 *l.* 19 *s.* 11 *d.* here (as before) consider that 19 *s.* 11 *d.* is $\frac{239}{240}$ of a Pound *Sterling*, and so the Question more rightly stated

£ d
in 3:19:11, there's 959 pence, wch £:d
multiplyed by 4 makes 15:19:8
wch I judge answers ye question, quære

959 multip.d by 959, is 919681, wch divided by 240
ye quote is 15:19:4, & a penny over, being one
 $\frac{1}{240}$ pt, ye number of pence in a pound

stated is, What's the Product of $3\frac{239}{240}$ by $3\frac{239}{240}$? *Ans.* 15 *l.* $\frac{55681}{57600}$. 57600 pts of a pound

A certain Person having $\frac{3}{5}$ of a Coale Mine sells $\frac{3}{4}$ of his share for 171 *l.* What's the whole Mine worth? *Ans.* 380 *l.* $\frac{3}{5}$

Reduce $\frac{3}{4}$ of $\frac{3}{5}$ to a simple Fraction, then as the Numerator Fraction to its Denominator, so is 171 to the Answer. The following Question is done after the same manner.

When the $\frac{2}{5}$ of $\frac{3}{4}$ of the share of a Ship is worth 147 *l.* 11 *s.* 3 *d.* how much is the whole worth? *Ans.* 491 *l.* 17 *s* 6 *d.*

A Father dying left his Son a certain Portion, of which he spent $\frac{1}{4}$, of the rest he spent $\frac{1}{2}$, and then he had 252 *l.* left, what Portion did the Father give him? *Answer,* 672 *l.*

From Unity take $\frac{1}{4}$ there remains $\frac{3}{4}$, next $\frac{1}{2}$ of $\frac{3}{4}$ to the simple Fraction of $\frac{3}{8}$, this $\frac{3}{8}$ take from $\frac{3}{4}$ it leaves $\frac{3}{8}$, then say as 3 to 8 so is 252 to the Answer required.

A younger Brother received 210 *l.* which was $\frac{3}{4}$ of $\frac{2}{3}$ of his elder Brothers Portion, now $3\frac{1}{2}$ times his elder Brothers Portion was $1\frac{1}{2}$ time his Fathers Estate. I demand the Fathers Estate. *Ans.* 2205 *l.*

Reduce $\frac{3}{4}$ of $\frac{2}{3}$ to a simple Fraction, then as the Numerator of the Fraction to its Denominator, so is 210 *l.* to the elder Brothers Portion; this multiplied by $3\frac{1}{2}$ or $\frac{7}{2}$

 gives

gives $1\frac{1}{3}$ or $\frac{4}{3}$ of the Fathers Eſtate; ſay therefore as 4 to 3, ſo is $3\frac{1}{2}$ the elder Brothers Potion to the Fathers Eſtate.

A Perſon making his Will gave to one Child $\frac{2}{5}$ of $\frac{3}{4}$ of his Eſtate, and to another $\frac{5}{6}$ of $\frac{2}{3}$ of his Eſtate, and when they counted their Portions the one had 543 *l.* 1 *s.* 9 *d.* more then the other. I demand what was the Fathers Eſtate. Anſwer, *The first had* 637 *l.* 10 *s.* 9 *d. the Second* 1180 *l.* 12 *s.* 6 *d. and the Fathers Eſtate is* 2125 *l.* 2 *s.* 6 *d.*

A Father gave to one of his Children $\frac{3}{4}$ of $\frac{2}{5}$ of his Eſtate, and of the remainder he gave another $\frac{1}{8}$ of $\frac{2}{3}$, and when they told their Money, the one had 173 *l.* 12 *s.* 4 *d.* more than the other, how much had each, and what was their Fathers Eſtate? Anſw. *The First had* 416 *l.* 13 *s.* 7 *d.* $\frac{1}{5}$, *the Second* 243 *l.* 1 *s.* 3 *d.* $\frac{1}{5}$, *and their Father's Eſtate was* 1388 *l.* 18 *s.* 8 *d.*

The method of ſolving theſe two Queſtions is not much unlike that of the Merchant, done by Reduction Second, Fourth and Subſtraction.

The

The Doctrine of Decimal Fractions.

WHAT a Fraction is, and how read, I have already declared in the Doctrine of Vulgar Fractions, and therefore ſhall here only ſhew the different way of noting theſe from that of Vulgar, with their great Uſe in the Solution of ſeveral Arithmetick Queſtions.

A Decimal Fraction is that which hath for its Denominator an Unite; with a certain Number of Cyphers as, 10, 100, 1000, 10000, *&c.* are all Denominators of Decimal Fractions.

Hence 'tis evident, that we divide the Unite into 10, 100, 1000, 10000, *&c.* equal Parts, for dividing it firſt into 10 equal Parts, and then each of thoſe again into 10 other equal Parts, will divide the Unite into 100 equal Parts, and if again we divide each other of thoſe Hundred equal Parts to Ten other equal Parts, the Unite or Integer will be divided into 1000 equal Parts; and ſo by Decimating the Firſt, and Subdecimating the Second, we proceed *ad Infinitum.*

Now becauſe the Denominators of Decimal Fractions differ only in the Number of Places, and not in the Figures, they being always an Unite with Cyphers, they may be expreſs'd without their Denominators with a point before them, as $\frac{6}{10}$ is thus expreſs'd .6 and $\frac{54}{100}$. thus, .054 alſo $\frac{27}{1000}$ thus. .027 and *Here obſerve*, that this point diſtinguiſhes them from whole Numbers.

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Hence the Denominator of a Decimal Fraction is eaſily known by the places of the Numerator, the Denominator being always one place more, as 6 hath 10 for its Denominator, and 054 hath 100, and 027 hath 1000 for its Denominator; underſtand the like of any other.

The order of places in Decimals is from Left to Right, and therefore contrary to the Order of places in a whole Number, which is from Right to Left, as in this Decimal, 548, here 5 is in the firſt place next the Left Hand, and ſignifies ſo many Tenth Parts of an Unite, and is therefore called *Primes*; the 4 in the Second place, ſignifies ſo many Hundred Parts of an Unite, and is called *Seconds*; the 8 in the Third place, denotes ſo many Thouſand Parts of an Unite or Integer, and is called *Thirds*, and ſo on as in the following Table.

The Notation TABLE for Decimals.

Tenth Parts of Unity.	3.	Primes.
Hundred Parts of Unity.	5.	Seconds.
Thousand Parts of Unity.	7.	Thirds.
X Thousand Parts of Unity.	9.	Fourths.
C Thousand Parts of Unity.	8.	Fifths.
Million Parts of Unity.	4.	Sixths.

This Table consists only of a Decimal Fraction, against which, above is set the Value of each place, and below its Name. From a little Consideration of what has been said 'tis evident, that Cyphers prefixt on the Right-hand of the Numreator of a Decimal Fraction, doth neither increase nor lessen its value, for .2 is of the same value with .20 or .200, &c. and therefore 'tis very easie reducing Decimal Fractions to a common Denominator, for 'tis but setting Cyphers on the Right-hand of the Numerator. As suppose .3 and .84, and .476, and .2356 were Decimal Fractions, and it was requir'd to reduce them to one Denominator; here I consider that the Denominator of the greatest Decimal given is 10000, I therefore add so many Cyphers to each of the Numerators that will make each of their Denominators to consist of 5 places, so that the above proposed Decimals when reduced stand thus .3000, and .8400, and .4760, and .2356.

I have been as clear as possible in explaining the Notation of these Numbers, because of the great falicity they bring with their practice in several Operations, not only in Arithmetick, but in most other parts of the Mathematicks. For had the Division of our *Money, Weight, Measure, &c.* been decimally, we had never been troubled with so many Fractions, which cause such

ſuch tedioufneſs in ſeveral Operations, and indeed the Art of Arithmetick would be Taught with much more eaſe and expedition than now it is, in caſe ſuch a Reformation ſhould ever be brought to paſs.

Addition of Decimals.

AS to the manner of adding, 'tis the ſame as in common Addition, the buſineſs being only to ſee if they are rightly placed, according to the manner of their Notation, which thing is eaſily effected by ſetting the point prefixt to them under each other, for then the reſt of the places will fall right whether they be whole Numbers and Decimals, or all Decimals, *ſee the following Examples,*

	Parts.	In. Parts.	In. Parts.
Add	.427	2. 43	27. 67
theſe to-	.3583	5. 67	615. 369
gether.	.67526	4. 38	2. 19
Summ	1.46056	12. 48.	645. 229.

Here you ſee, in all theſe Caſes, that *Primes* ſtands under *Primes*, *Seconds* under *Seconds*,

conds, &c. and where Integers are join'd with Decimals, there *Unites* stands under *Unites*, and *Tens* under *Tens*, &c. in which Examples 'tis very plain, that the Method of adding is just as it was in whole Numbers, only you are to make the Summ consist of somany Decimal places as is in the greatest parts of it: So in the first Example the Summ consisted of six places, or Figures, and the greatest part of the Summ but of Five, I therefore cut off Five Figures in the Summ towards the Right-hand for the Decimal parts, the remainder on the Left are Integers.

Note, That in this, and the following Rule, the Decimals given to be added, or substracted, must be parts of the same whole.

More Examples.

What's the Summ of 29 and 3.007 and .94 and 89.76. *Answ.* 122 *In.* 707 *Parts.*

What's the Summ of 3.87 and 486 and .4 and .025. *Answ.* 490 *In.* 295 *Parts.*

What's the Summ of 59.4 and 8.796 and 472.6 and .142, *Answ.* 540 *In.* 938 *Parts.*

Note, That *In.* over the preceding and following Summs stands for *Integres*, and *Pts.* for *Parts.*

Sub-

Substraction of Decimals.

THE Operation here is in all respects like to that in Vulgar Substraction, the main thing (as in the last) being only to see that they are rightly placed, which is done by the Direction given in the foregoing Rule of Addition. *See the following Examples.*

	Pts.	*In. Pts.*	*In. Pts.*
from	.456	2. 352	58. 100
take	.287	.870	.296
Rema.	.169	1. 482	57. 804

Here you see we Substract as in common Substraction, only observe that where the Decimals have not an equal Number of places, the vacancies are supplied with Cyphers, or understood so to be, especially in the upper Number.

More Examples.

From 15 Substract 7. 8. *Answ.* 7. 2.
From 1 Substract .9872 *Answ.* .0128.
From 58. 6 Substract 3. 98625. *Answer,* 54. 61375.

Mul-

Multiplication of Decimals.

IN Multiplication of Decimals, both the manner of placing and multiplying is in all Respects and Cases the same with that of placing and multiplying whole Numbers, the business here being only to find the whole value of the Product after the Operation is ended, which to do take this general

RULE.

See *how many Decimal places there are in the Multiplicand and Multiplyor, and from the Product towards the Right-hand, cut off so many as are in both these, so shall the Figures on the Right-hand of the point be Decimal places, and those on the Left-side Integers.* See the Example following.

	5.46	21.67	.6723
	.14	2.3	.63
	2184	6501	20169
	546	4334	40338
Prod.	.7644	49.841	.423549

But

But if when the Multiplication is ended, there arise not so many Figures in the Product as ought to be cut off, then is such defect to be supplied by annexing as many Cyphers on the Left-hand thereof as there wants places, with a point before them, and you have the true value of the Product. See the following *Examples*.

	.158	.227
	.6	.02
Product	.948	.0454
True Prod.	.0948	.00454

The consideration of this Practice will be of some help to you, in finding the true value of the Quote in Division.

More Examples.

Mult.	4.00000	.000001	232
by	.000003	.900	.438
Porduct	1.200000	.000000900	101.616

There is in this kind of Multiplication a certain way of Contraction, by which you may get the Product to as few or many places

places as you please, without the tedious Multiplication of the whole: The Method of which is as follows.

As suppose 9.58 was to be Multiplied by 8.79, here 'tis evident the Decimal will consist of four places, and only two would be sufficient.

Set down the bigger of the two Quantities for the Multiplicand, and then set the place of Unites in the Multiplior, under that place of Parts in the Multiplicand you would have the Product; this done, invert the order of all the other places in the Multiplior, that is, set the place of Tens where Primes should be, and the place of Primes where Tens should be, and so on with the invertion of the rest; then let each Figure of the Multiplior multiply that of the Multiplicand which is just over, remembring to add what would have been brought thither from the following places, which done, add up all together, and from the Sum cut off two Figures (in this *Example*) next the Right Hand, and you have your desire; all which by the following Examples, compared with this Direction, will plainly appear.

Example

Example I.

By the common way.		By Contraction.
9.58	Multiplicand	9.58
8.79	Multiplior	97.8
84.2082		7664
		670
		86
	Product	84.20

Example II.

By the common way.		By Contraction.
342.6894	Multiplic.	342.6894
52678	Multiplior	87625
18052.1922132		17134470
		685378
		205613
		23988
		2741
	Product	18052.190

This last was required to three places, where you see they are seperated by a Point toward the right Hand, being 190, but should have been 192, which small Error

Error is caused by the want of the carriage from the next row, and therefore if you would have it exactly to three places, especially in great Sums, you ought to do it to four.

Division of Decimals.

THE manner of working Decimal Division is in every thing like to that of Common Division, and therefore no regard as to their Place and Nature is here to be had, any more than what was in Division of whole Numbers, the Mistery of this lying *First*, In their Preparation when need requires. *Secondly*, In finding the true value of the Quote after the Division is ended.

First, Therefore when it happens that the Divisor hath more places than the Dividend, you must put to the right Hand of the Dividend, (whether it be a whole Number, mixt or Decimal Fraction) a certain number of Cyphers at pleasure, by which it is made fit for Operation.

As suppose 14 was to be divided by 361, 'tis evident here is an absolute necessity of prefixing Cyphers to 14 the Dividend, before you can divide by 361 the Divisor.

I judge cyphers must be placed to y^e^ right hand of 14000 0

The

The Dividend being thus prepared, take notice there muſt be as many Decimal places in the Diviſor and Quotient as are in the Dividend, for the Dividend is in effect the Product, and the Diviſor and Quotient the Multiplicand and Multiplior, and therefore for the finding the Value of the Quotient this is the

Rule.

Look how many Decimal places are in the Dividend more than in the Diviſor, for ſo many Decimal places will there be in the Quote.

And therefore when it happens the Dividend hath not ſo many decimal places as the Diviſor, then muſt ſuch defect be ſupply'd by annexing Cyphers to the Right Hand of the Dividend.

```
      .56)24(            |        83).35(
  .56)24.0000(42.85      |  83).350000(4216
      224                |      332
      ---                |      ---
       160               |      .180
       112               |       166
       ---               |       ---
        480              |       .140
        448              |         83
        ---              |        ---
         320             |         570
         280             |         498
         ---             |         ---
         .40             |          72
```


Having

this relates to ye exam:
in page (97)

Having annexed 4 Cyphers to each of the Dividends, the first Dividend being an Integer, consists only of the 4 Decimals added; but the later being a Decimal, is made to consist of 6 Decimals. They being thus prepared, and the work of Division over, you see the Quote consists of 4 places; now considering how many Decimal places there is in each of those Dividends, more than in their proper Divisors, and you shall find, that in the first Quote there ought to be two places of Decimals, and in the second six of the like places, which because there is but four I prefix two Cyphers on the left Hand thereof, it gives .004216 the true Quote.

viz-24

35.0000

42.85

4216

Some Examples.

84)3.5(	5.4)1.5(	.9).004(	.63)1(
prepared 3.50000	prep. 1.50000	prep. .004000	prep. 1.0000
true Quote .04166	true Q. .2777	true Q. .00444	true Q. 1.58

I have to these four Examples set only the Dividends prepared with their Quotients truely valued, the consideration of which, with the preceding direction, I hope will be a sufficient light in all other Cases that can happen.

Reduction

Reduction of Decimals.

WHAT I here design is to show you how *to reduce a Vulgar Fraction to a Decimal*, and contrary, which is no more than what in effect was done in *Reduction the Fifth of Vulgar Fractions*; only here I shall perticularly apply it to the business of Decimals.

To reduce a Vulgar Fraction to a Decimal.

Rule, Multiply the Numerator of the Vulgar Fraction by 10, 100, 1000, *&c.* according to the number of places you would have the Decimal to consist, the Product divide by the Denominator it gives the Decimal required.

Example I. Reduce $\frac{3}{4}$ to a Decimal Fraction.

3 Numer. Vulg. Fract.
100 Denom. Decimal.

4)300(.75

20

So that .75 is the Decimal equivalent to $\frac{3}{4}$.

Note. From the preceding Rule 'tis evident, *That if to the Numerator of any Vulgar Fraction, you annex so many Cyphers as you would have your Decimal to consist of places*, and divide by the Denominator, the Quote gives the Decimal required.

Example II. Reduce $\frac{15}{19}$ to a Decimal of five places.

To 15 the Numerator of the given Vulgar Fraction, I annex 5 Cyphers, it makes 1500000, this I divide by 19 the Denominator, the Quote is the Decimal required. *See the following Operation.*

```
19)1500000(78947
   170
    180
     090
      140
        7
```

So that the Decimal equal to the given Vulgar Fraction is .78947, which because of the remainder is not exactly true, but yet so near that it wants not $\frac{1}{100000}$ part of a Unite of the Truth, and if you proceed farther to make the Decimal consist of six places it will be 789473, and then it will not want $\frac{1}{1000000}$ part of an Unite of the Truth; for if the Decimal be made .789474 it will exceed the true value.

And thus by increasing the number of places in the Decimal, you may at last come infinitely near, tho' never to the Truth it self.

Example III. Reduce $\frac{1}{32}$ to a Decimal of five places.

```
32)100000(3125
   ------
     40
    ----
     80
    ----
     160
    -----
```

Here (because the Decimal is required to five places) I add five Cyphers to 1 the Numerator of the given Fraction, and then divide by 32 the Denominator, the Quote gives 3125 for the Decimal sought.

this relates to exam:
page (101)

But here note, That because I annex five Cyphers to 1 the given Numerator, and there arises but four Figures in the Quote, I must supply such defect by prefixing as many Cyphers on the left Hand of the first Figure in the Quote as there wants places, as in the *preceding Example*, where the Quote consisted but of four places; here I annex a Cypher on the left Hand of 3, the first Figure in the Quote, and then it becomes .03125 the true Decimal required.

To reduce the known parts of Money, Weight, Time, *&c. to a Decimal.*

From what precedes 'tis evident how the known parts of *Money*, *Weight*, *Time*, &c. may be turn'd into a Decimal of the same value, or infinitely near it; for if in Money a Pound *Sterling* be an Integer, whatsoever is less than a Pound is either a part or parts of the same; and when you know what part or parts thereof it is, you may easily reduce it to a Decimal of the same value from what was taught in the last.

Example, What's the Decimal of 9 *s.*? That is reduce $\frac{9}{20}$ to a Decimal consisting of two places.

20

20)900(45

100

Here working according to what hath been before directed, I find the Decimal of 9 *s.* to be .45.

So if I would know the Decimal of 9 *d.* consider that 9 *d.* is $\frac{9}{12}$ of $\frac{1}{20}$ of a Pound, or $\frac{9}{240}$.

Work therefore according to the preceding Rule, and you'l find the equivalent Decimal .0375.

Again, if I would know the Decimal of 3 Farthings, here I consider that 3 Farthings is $\frac{3}{4}$ of $\frac{1}{12}$ of $\frac{1}{20}$ or $\frac{3}{960}$ of a Pound, and therefore working as before, I find the Decimal to be .0031 near.

Lastly, If it were required to find the Decimal of 7 *s.* 8 *d.* $\frac{3}{4}$, that is 371 Farthings, or $\frac{371}{960}$, here repeating the like Operation, I find the equivalent Decimal to be .3864; the like is to be understood in reducing to Decimals the known parts of *Weight*, *Time*, *Measure*, *Motion*, &c.

To find the value of a Decimal Fraction in the known parts of Money, Weight, Time, Measure, Motion, *&c.*

This is but the Converſe of the former, and therefore the Rule for finding the true value of a Decimal is grounded upon the ſame reaſon as that of turning any part of Coyn, *&c.* to a Decimal.

For 'twil hold as the Decimal Denominator is to its Numerator, ſo is the parts of the next inferior Denominator to the Numerator or Number of ſuch parts contain'd in the Decimal.

note this rule

And hence comes this Rule. *Multiply the given Decimal by the parts of the next inferiour Denomination that is equal to the Integer the Decimal gives the part of, and from the Product cut off ſo many Figures toward the right Hand as there are places in the given Decimal, the remaining Figures on the left ſide are the value of the ſaid Decimal in ſuch Denomination; if any thing remain, it is the Decimal of an Integer in the Denomination laſt found, and may be reduced as low as you pleaſe by the ſame Rule, and after the ſame manner as it was in* Reduction *the 5th of Vulgar Fractions.*

noted in page (67) & (68)

Exam-

y: valuing of this decimal is found to

 in page (142)

Example, *How much is* .3765 *of a Pound* Serling ? *I say,*

as 10000 *to* 3765 *so is* 20 *to* 7 *s.* 6 *d.* $\frac{1}{4}$ .44

20
7.5300
12
6.3600
4
1.4400

So that from the preceding Work I find the true value of this Decimal .3765 of a Pound *Sterling* to be 7 *s.* 6 *d.* $\frac{1}{4}$ .44; after a like process may the value of any Decimal of *Weight*, *Time*, *Measure*, &c. be found.

More *Examples* of this kind will be needless, I shall therefore forbear, and in the room thereof give you a Practical Rule for finding the value of any Decimal of a Pound *Sterling*, as soon as ever you here it nam'd.

Rule, *The Figure in the first place, or place of Primes, being doubled gives you the number of Shillings, and if the Figure in the Second*

in page (142)

cond place be 5, or above it, take 1 Shilling for the 5, and add to the former Number found by doubling; Then for that which remains above 5, with the Figure in the Third place, count ſo many Farthings leſs by 1, that thoſe two Figures make, being ſet in a numeral order, or if the Figure in the Second place be under 5, then reckon ſo many Farthings wanting 1 as that and the Figure in the Third place of the Decimal make in Number. An *Example* or two will make it plain.

Exam. I. *What's the .375 of a Pound* Sterling?

Here I double 3 which ſtands in the place of Primes, and that gives 6 *s.* then because the next Figure 7 is above 5 I add 1 Shilling to the 6 before found, and it makes 7 *s.* then the 2 left of the 7 with the 5 in the place of thirds makes 25, which being leſſen'd by 1 is 24 Farthings, ſo that the value of .375 is 7 *s.* 6 *d.*

Exam. II. *What's .719 of a Pound Sterling?*

Here the firſt Figure 7 doubled gives 14 for the number of Shillings as before, and for the other 19 that remains I account

18

18 Farthings, which is 4 *d.* $\frac{1}{2}$, so that the value of the Decimal .719 14 *s.* 4 *d.* $\frac{1}{2}$.

More Examples might here be given, but I think these are sufficient to Illustrate this Practical way of finding the Decimal of a Pound *Sterling*.

I shall therefore conclude this with the incertion of a Decimal Table, for finding the value of any Decimal part of a Pound *Sterling*, omitting those of *Weight*, *Measure*, *Time*, &c. because of their being so seldom used, and if required, so easily Calculated from the aforemention'd Proportion, and likewise for their frequency in Books of this Nature.

A TABLE, *shewing the Decimal of any part of a Pound* Sterling, & contra.

Shillings.	19	.95	Pence.	11	.04583
	18	.9		10	.04167
	17	.85		9	.0375
	16	.8		8	.03333
	15	.75		7	.02917
	14	.7		6	.025
	13	.65		5	.02083
	12	.6		4	.01667
	11	.55		3	.0125
	10	.5		2	.0083
	9	.45		1	.00417
	8	.4			
	7	.35			
	6	.3			
	5	.25	Farth.	3	.00312
	4	.2		2	.00208
	3	.15		1	.00104
	2	.1			
	1	.05			

The

The Use of the Table.

The method of making this Table is evident from what precedes, and its use almost apparent. For let the Decimal of 13 *s.* 7 *d.* ½ be required, seek in the Table first for the Decimal of 13 *s.* which is .65, next for the Decimal of 7 *d.* which is .02917, and lastly for the Decimal of ½, which is .00208, I set these Decimals in the order following, and add them together.

13 *s.*	.65
7 *d.*	.02917
2 *q.*	.00208
13 *s.* 7 *d.* ½ *q.*	.68125.

By which you see the Decimal of 13 *s.* 7 *d.* ½ is .68125. In like manner may the Decimal of any other Sum be found, as also the Sum belonging to any given Decimal.

The Use of Decimals.

TO shew the use of these Numbers in all Solutions where they might be us'd in expediting an Operation would be endless,

they

they being of great uſe in moſt parts of the Mathematicks; but principally in *Gauging, Surveying, Meaſuring, Calculating Tables of Intereſt, Raiſing of Logarithens*, as may be ſeen in moſt Books that have writ of theſe Subjects; I ſhall therefore omit giving Examples of uſing them in any of theſe parts, except I had treated diſtinctly of each of them; and ſhall cloſe this Paragraph with the Collection of a few eaſie Queſtions, which are ſpeedily ſolv'd by theſe Numbers.

By Multiplication.

In 756 Piſtoles at 18 *s.* each, how many Pounds *Sterling*? *Anſwer*, 680 *l.* 8 *s.*

In 439 Guinea's, at 22 *s.* 6 *d.* each, how many Pounds *Sterling*? *Anſwer*, 493 *l.* 17 *s.* 6 *d.*

If I ſpend 4 *s.* 6 *d.* *per* Day, how much is that for one Year? *Anſwer*, 82 *l.* 2 *s.* 6 *d.*

If a Yard of Cloath is worth 6 *s.* 9 *d.* what comes 59 Yards to at that rate? *Anſwer*, 19 *l.* 18 *s.* 3 *d.*

If a Piece of Pavement be 34 Foot 6 Inches long, and 24 Foot 9 Inches broad, what's the Content in ſquare Feet? *Anſwer*, 853 Foot .875.

If one Man's ſhare in the Cargo of a Ship comes to 38 *l.* 14 *s.* what was the the whole worth ſuppoſing there was 158 Men

Men in the Ship? *Answer*, 6114 *l.* 12 *s.*

If the Intereſt of 500 *l.* for one Day is 2 *s.* 3 *d.* what's that for a Year? *Anſwer*, 41 *l.* 1 *s.* 3 *d.*

By Diviſion.

In 680 *l.* 8 *s.* how many Piſtoles at 18 *s.* each? *Anſwer* 756.

In 493 *l.* 17 *s.* 6 *d.* how many Guinea's at 22 *s.* 6 *d.* each? *Anſwer* 439.

If I ſpend 82 *l.* 2 *s.* 6 *d.* in one Year, what is that for one Day? *Anſwer* 4 *s.* 6 *d.*

If 59 Yards of Cloath coſt 19 *l.* 18 *s.* 3 *d.* what coſt 1 Yard? *Anſwer* 6 *s.* 9 *d.*

If the Content of a Piece of Paving be 853 Foot .875, and the length 34 Foot 6 Inches, what's the true breadth? *Anſwer* 24 *Foot* 9 *Inches.*

If the whole Cargo of a Ship be 6114 *l.* 12 *s.* and there be 158 Men in the Ship, what comes each Man's ſhare to? *Anſwer* 38 *l.* 14 *s.*

If the Intereſt of 500 *l.* for a Year is 41 *l.* 1 *s.* 3 *d.* what is that for one Day? *Anſwer* 2 *s.* 3 *d.*

I conceive it needleſs to meddle with the *Rule of Three*, being in all kinds and reſpects perform'd like that in Vulgar Fractions, I ſhall therefore leave the Exerciſe

of

of Questions of this Nature to the Ingenious.

Practice.

PRactice is a Rule by which the value of any part or parts of a *Pound*, *Ell*, *Yard*, &c. or any number of *Pounds*, *Ells*, *Yards*, &c. may be briefly found or cast up, when the Price of *One* or *Unity* is given, and this is done by considering what part or parts of a *Penny*, *Shilling* or *Pound* the price of *One* or *Unity* is.

In order to do this 'tis necessary to learn what the Aliquot parts of a Penny, Shilling and Pound are, for by this you may mentally Multiply and Divide, *that is*, putting down only the Products without the Multiplyors and Divisors, they being always small.

The Method I shall prosecute in this will be somewhat different from several Authors, For *Example*, Suppose 4952 Days at 1 Farthing *per* Day; here instead of taking a Farthing, the $\frac{1}{960}$ of a Pound, I take it as the $\frac{1}{4}$ of a Penny, and so practically divide 4952 by 4 it gives 1238 Pence, for so many Fours as are in 4952, so many Pence will those Days amount to; these Pence

Pence I practically divide by 12 to reduce them to Shillings, and the Shillings by 20 to turn them into Pounds.

Again suppose 2864 Ells at a Half-penny an Ell, here instead of considering a Half-penny as $\frac{1}{480}$ of a Pound, I take it as the half of a Penny, and so divide 2864 by 2 it gives 1432 Pence, because every 2 gives a Penny, and therefore so many Two's as are in it, so many Pence they must amount to; after which I divide those Pence by 12 to reduce them to Shillings, and then by 20 to bring them into Pounds.

My Reason for so Operating is, because I count two or three small Divisions more practical and sooner perform'd than one large Division. First, Because a Mistake is sooner made in a large Division than in a small one, and Secondly there is many times a large remainder which requires some trouble to reduce to Pence and Shillings.

But before I proceed any farther, it is absolutely necessary the Learner get the following Table by Heart.

A Table of the Aliquot Parts of a Shilling.

1 *d.*	is	$\frac{1}{12}$	of a Shilling.
1 *d.* $\frac{1}{2}$	is	$\frac{1}{8}$	——Shil.
2 *d.*	is	$\frac{1}{6}$	——Shil.
3 *d.*	is	$\frac{1}{4}$	——Shil.
4 *d.*	is	$\frac{1}{3}$	——Shil.
6 *d.*	is	$\frac{1}{2}$	——Shil.

These are all the Aliquot parts of a Shilling, and their uſe is to find the value of any number of things, when the price of one of thoſe things is one of theſe Aliquot parts: As ſuppoſe 852 Ounces at 1 *d.* an Ounce, here 'tis evident 12 Ounces will come to juſt 1 *s.* If therefore I divide 852 by 12 the Quote will give 71, the number of Shillings thoſe Ounces amonnt to, which is eaſily turn'd into Pounds by dividing by 20. Again, Suppoſe 568 Drams, at 1 *d.* $\frac{1}{2}$ a Dram, here every 8 Drams will amount to 1 Shilling, therefore ſo many Eights as are in 568, ſo many Shillings will thoſe Drams amount to.

The like is to be underſtood if the price be 2 *d.* 3 *d.* 4 *d.* or 6 *d. per Ounce, Dram,* &c. for then if you divide the number of *Ounces, Drams,* &c. by 6 it will give you their price in Shillings at 2 *d.* each; if by 4 at

3 *d.* each; if by 3 at 4 *d.* each; if by 2 at 6 *d.* each; for six two Pences make one Shilling, and four three Pences make one Shilling; so also doth three Groats, and likewise two six Pences.

But if the price of the Integer be more than one Shilling, 'tis best done by the Aliquot parts of a Pound (except in some Cases which shall hereafter be shown) the Table of which is as followeth,

A TABLE of the Aliquot Parts of a Pound, &c.

s.	d.		
1	0	is the $\frac{1}{20}$	of a Pound *Sterling.*
1	8	is $\frac{1}{12}$	——Pd.
2	0	is $\frac{1}{10}$	——Pd.
2	6	is $\frac{1}{8}$	——Pd.
3	4	is $\frac{1}{6}$	——Pd.
4	0	is $\frac{1}{5}$	——Pd.
5	0	is $\frac{1}{4}$	——Pd.
6	8	is $\frac{1}{3}$	——Pd.
10	0	is $\frac{1}{2}$	——Pd.

The use of this Table is like the former, *viz.* to find the amount of any number of things when the price of One or Unity is

 given,

only with this difference when the price is above a Shilling.

As suppose 460 Yards at 1 *s.* the Yard, here 'tis manifest 20 Yards will be 20 *s.* and therefore if I divide 460 by 20 the Quote 23 is the number of Pounds those Yards will cost. Again, Suppose 384 Ells at 1 *s.* 8 *d.* the Ell, here every 12 Ells will come to 1 *l.* if therefore I divide by 12 the Quote 32 is the number of Pounds those Ells will cost. Understand the like if the price be 2*d.* 2 *s.* 6 *d.* 3 *s.* 4 *d.* 4 *s.* 5 *s.* 6 *s.* 8 *d.* or 10 *s.* *per Ounce*, *Dram*, *Ell*, *Yard*, &c. for then if you divide the number of *Ounces*, *Drams*, *Ells*, *Yards*, &c. by 10, 'twill give you their price in Pounds at 2 *s.* each; if by 8 'twill give it at 2 *s.* 6 *d.* each; if by 6 at 3 *s.* 4 *d.* each; if by 5 at 4 *s.* each; if by 4 at 5 *s.* each; if by 3 at 6 *s.* 8 *d.* each; if by 2 at 10 *s.* each; which is evident from the foregoing reason in the Table of Pence.

2s

But if the price of the Integer be not the Aliquot of a Shilling or Pound, but uneven and compounded, that is Pounds, Shillings and Pence, do as in the following Example.

Example, What comes 489 Ounces of Cochinele to at 2 *l.* 13 *s.* 7 *d.* $\frac{1}{4}$ the Ounce?

I ſhall firſt practically operate this Example, and then ſhew by what Methods and Rules I Work.

Ounces		l.	s.	d.	
489	at	2	13	7 $\frac{1}{4}$	the Ounce.
2			10	6	
			2	1	
			1		

978 l.			
244 l.	10 s.		
48 l.	18 s.		
24 l.	9 s.		
12 l.	4 s.	6 d.	
2 l.	0 s.	9 d.	
1 l.	10 s.	6 d.	$\frac{1}{4}$
1311 l.	12 s.	9 d.	$\frac{3}{4}$

In the firſt place, becauſe there is Pounds in the price of the Integer, I multiply the given Number of Integers by the Pounds, (part of the price of an Integer) the Product muſt evidently be the Pounds they coſt, were there no odd Shillings and Pence, for 489 Ounces at 2 *l.* the Ounce muſt come to 978 *l.* And ſo if it had been 3, 4, 5, *&c.* Pounds you muſt have multiplied by 3, 4, 5. *&c.* to have got the Pounds.

In the next place is 13 *s.* which becauſe no Aliquot part of a Pound, I therefore take the next even number of Shillings that

are leſs than the ſaid odd number, which in this caſe is 10, and therefore $\frac{1}{2}$ of a Pound; ſo I take $\frac{1}{2}$ of 489 and ſet under the former Product, it gives the number of Pounds they would coſt at 10 *s.* the Ounce, which if added to the former would be the price at 2 *l.* 10 *s.* each; but becauſe there are Shillings, Pence and Farthings yet remaining that are part of the price, I proceed farther, and take 2 *s.* to be the $\frac{1}{5}$ of 10 *s.* which 2 I ſet under the 10, and then take $\frac{1}{5}$ of 244 *l.* 10 *s* (which is 48 *l.* 18 *s.*) and place under it, next I place 1 *s.* as $\frac{1}{2}$ of 2, under 2, and take $\frac{1}{2}$ of 48 *l.* 18 *s.* placing it underneath, this compleats the number of Shillings.

Then for the Pence, which becauſe they are not an Aliquot part of a Shilling, I take the next leſs number that is an Aliquot part, which is 6, and conſequently the half of a Shilling, and therefore I take $\frac{1}{2}$ of 24 *l.* 9 *s.* which is 12 *l.* 4 *s.* 6 *d.* this I ſet under the 24 *l.* 9 *s.* Then I place 1 under the 6, which is 7 *d.* and take it as $\frac{1}{6}$ of 6 *d.* taking alſo the $\frac{1}{6}$ of 12 *l.* 4 *s.* 6 *d.* which is 2 *l.* 0 *s.* 9 *d.* and this is the price of 489 Ounces at 1 *d.* the Ounce.

Laſtly for the Farthings, which becauſe 3, and therefore the $\frac{1}{8}$ of 6 *d.* I take the $\frac{1}{8}$ of 12 *l.* 4 *s.* 6 *d.* which is 1 *l.* 10 *s.* 6 *d.* $\frac{3}{4}$, and ſet under the former, then I ſum up the whole row, that is, I caſt up the ſum of

theſe

these several rates, *viz.* at 2 *l.* the Ounce, at 10 *s.* the Ounce, 1 *s.* the Ounce, 6 *d.* the Ounce, 1 *d.* the Ounce, and 3 Farthings the Ounce, all which rates added together makes 2 *l.* 13 *s.* 7 *d.* $\frac{3}{4}$, the price of the Ounce given, and the sum of their prices will be 1311 *l.* 12 *s.* 9 *d.* $\frac{3}{4}$, the price of 489 Ounces at 2 *l.* 13 *s.* 7 *d.* $\frac{3}{4}$ the Ounce.

Note, 1*st*. What remains is always of the same Name with the Dividend, as in the preceeding Example and first Division, which was halving or dividing by 2, there the 1 remaining was 1 Pound.

2*dly*, If there had been half or a quarter of an Ounce, you must have taken half or a quarter of the price of the Ounce and added to the former Sum.

3*dly*, When the Price of the Integer is above 1 Shilling, yet under 20 Pence, 'tis best done by the Aliquot of a Shilling; for any number of Pence under 20 is above the $\frac{1}{12}$ of a Pound, and above 12 we cannot practically divide.

4*thly*, If the number of Integers be under 13 'tis speedily done by multiplying the price of the Integer by the number of things; for *Example*.

9 Ounces of Silver at 5 *s.* 7 *d.* $\frac{1}{2}$ the Ounce.

5 s. 7 d. ½
9

2 l. 10 s. 7 d. ½ *Answer.*

5thly, When the Price of the Integer is 2 s. 'tis but cuting off one Figure to the Right Hand, and the remainder to the Left is the price in Pounds. *Example*,

at 2^{d} p day quere

2463 Days at 2 s. *per* Day.

246 l. 6 s. *Answer.*

2463 at 2^{d}

246 – 6

6thly, If the Price of the Integer be 10 s. 'tis but halving or dividing by 2 and the Quote is Pounds. *Example.*

648 Men at 10 s, *per* Man.

324 l. *Answer.*

7thly, If the price of the Integer be 2 or 3 Farthings, chuse rather to multiply by 2 or 3, then will the Product be Farthings, which are easily turn'd into Pounds by dividing by 4, 12 and 20.

Many other Contractions there are in this Rule, which would be too numerous

to

to Incert in this Treatiſe, and therefore for Brevity ſake I omit them, and ſhall cloſe up this Rule with the following Collection of Queſtions, and their Anſwers.

Queſtions to be done by Practice.

964 Lemmons at ¾ *per* Lemmon? *Anſ.* 3 *l.* 0 *s.* 3 *d.*

679 Yards at 1 *d.* the Yard? *Anſwer* 2 *l.* 16 *s.* 7 *d.*

498 Ells at 2 *d.* the Ell? *Anſwer* 4 *l.* 3 *s.* 0 *d.*

576 Ells *Flemiſh*, at 3 *d.* the Ell? *Anſw.* 7 *l.* 4 *s.* 0 *d.*

498 Ounces at 4 *d.* the Ounce? *Anſw.* 8 *l.* 6 *s.* 0 *d.*

674 Pieces at 5 *d.* the Piece? *Anſwer* 14 *l.* 0 *s.* 10 *d.*

376 Pounds at 6 *d.* the Pound? *Anſwer* 9 *l.* 8 *s.* 0 *d.*

298 Drams at 7 *d.* the Dram? *Anſwer,* 8 *l.* 13 *s.* 10 *d.*

676 Days at 8 *d.* the Day? *Anſwer,* 22 *l.* 10 *s.* 8 *d.*

568 Men at 9 *d. per* Man? *Anſwer,* 21 *l.* 6 *s.* 0 *d.*

793 Days at 10 *d.* the Day? *Anſwer,* 33 *l.* 0 *s.* 10 *d.*

374 Men at 11 *d. per* Man? *Answer*, 17 *l.* 2 *s.* 10 *d.*

694 Gallons at 9 *d.* ½ the Gallon? *Ans.* 27 *l.* 9 *s.* 5 *d.*

498 Quarts at 11 *d.* ¾ the Quart? *Ans.* 24 *l.* 7 *s.* 7 *d.* ½.

268 Pints at 7 *d.* ¼ the Pint? *Answer*, 8 *l.* 1 *s.* 11 *d.*

196 Penny-weights at 1 *s.* the Penny-weight? *Answer*, 9 *l.* 16 *s.* 0 *d.*

374 Scruples at 1 *s.* 2 *d.* the Scruple? *Answer*, 21 *l.* 16 *s.* 4 *d.*

284 Ounces at 5 *s.* 4 *d.* the Ounce? *Ans.* 75 *l.* 14 *s.* 8 *d.*

148 Feet at 8 *s.* 7 *d.* ½ the Foot? *Answ*, 63 *l.* 16 *s.* 6 *d.*

426 Pounds at 13 *s.* 6 *d.* ½ the Pound? *Answer*, 289 *l.* 9 *s.* 9 *d.*

214 Guineas at 1 *l.* 1 *s.* 10 *d.* each? *Answer*, 233 *l.* 12 *s.* 4 *d.*

159 Pistols at 17 *s.* 2 *d.* each? *Answer*, 136 *l.* 9 *s.* 6 *d.*

436 Pieces of Eight at 5 *s.* 9 *d.* ¼ each? *Answer*, 125 *l.* 16 *s.* 1 *d.*

2000 Ducats at 4 *s.* 11 *d.* ¼ each? *Ans.* 497 *l.* 18 *s.* 4.

1700 Gelders at 1 *s.* 8 *d.* the Gelder? *Answer*, 141 *l.* 13 *s.* 4 *d.*

685 Liures at 1 *l.* 9 *s.* ½ *per* Liure? *Ans.* 1010 *l.* 7 *s.* 6 *d.*

495 Pieces of Gold at 17 *s.* 9 *d.* ½ *per* Piece? *Answer*, 440 *l.* 6 *s.* 10 *d.* ½.

7

7 Hogs-heads of Oyl at 13 *l.* 15 *s.* 7 *d.* ¼ the Hogs-head? *Ans.* 96 *l.* 9 *s.* 2 *d.* ¾.

19 Hundred ½ of Cochinele at 7 *l.* 17 *s.* 6 *d. per* Hund. *Ans.* 153 *l.* 11 *s.* 3 *d.*

13 Ingots of Silver each weight 21 ℔. ¼ at 4 *l.* 3 *s.* 6 *d. per* Pound? *Answer*, 1156 *l.* 6 *s.* 10 *d.* ½.

quære if not 1153

64 Tun 3 Hoghs-heads at 21 *l.* 10 *s.* 11 *d. per* Tun? *Ans.* 1395 *l.* 1 *s.* 10 *d.* ½.

26 C. ¾ 20 ℔. of Sugar at 5 *l.* 13 *s.* 6 *d. per* C. *Ans.* 152 *l.* 16 *s.* 4 *d.* ¼.

5 ℔. 9 *Ou.* 16 *Dwt.* of Gold at 4 *l.* 1 *s.* 0 *d.* ½ the ℔. *Ans.* 23 *l.* 11 *s.* 4 *d.* ½.

76422 Men at 1 *s.* 2 *d.* ¾ each Man? *Answer*, 4696 *l.* 15 *s.* 4 *d.* ½.

84 *Ou.* 15 *Pw.* 17 *Gr.* at 4 *l.* 1 *s.* the Ounce? *Ans.* 343 *l.* 7 *s.* 7 *d* ½.

What comes ¾ of an Ounce of Gold to at 4 *l.* 7 *s.* 9 *d.* the Ounce? *Answer*, 3 *l.* 5 *s.* 9 *d.* ¾.

What comes 17 *Pw.* 15 *Gr.* of Carmine to at 9 *l.* 13 *s.* 6 *d. per* Ounce? *Answer*, 8 *l.* 10 *s.* 6 *d.*

What comes 3 *Ou.* 7 *Pw.* 12 *Gr.* of Ultramarine to at 7 *l.* 19. 8 *d.* the Ounce? *Answer*, 26 *l.* 18 *s.* 10. ¼.

5 Wedges of Gold each 3 ℔. ½ at 50 *l.* 17 *s.* 6 *d.* the Pound? *Answer*, 890 *l.* 2 *s.* 3 *d.*

4 Tun, 3 Hoghs-heads, 36 Gallons, at 21 *l.* 14 *s.* 2 *d. per* Tun? *Answer*, 106 *l.* 5 *s.* 2 *d.*

Of

Of Tare and Trett.

THIS *Rule* we generally annex to *Practice*, because the Directions given for casting up their allowances are by Practice.

In order to this you are to understand, that most Commodities which are either brought from beyond Sea, or carried thither, are put up in a Chest, Box, Bag, Basket or such like, and when taken out of the Ship are weighed with the Vessel or Thing they are put up in, which weight is called the *Gross weight*.

Tare is an allowance made by the Queen to the Merchant, and of the Merchant to the Buyer; for the weight of such Vessel, Bag or Basket wherein the Commodity is put.

Trett is an allowance of 4 ℔. in every 104 ℔. for Wast and Dirt on some sort of Goods, and is allowed only by the Merchant to the Buyer, and not to the Merchant in paying of Custom.

If your Commodity be such that has an allowance for Trett, then having found the Tare take it from the Gross weight, the remains is the Subtle weight; then find out the

the Trett by the following Rule, which deduct from the Subtle, leaves the Nett weight.

But note, that in such Commodities where there is no Trett to be allowed, there having taking the Tare weight from the Gross weight, the remains are Nett weight.

How to find the Tare.

Rul. *Multiply the Hundred weights of Chests, Bags, &c. by the Pounds Tare allowed for one Hundred weight Chest, Bag, &c. The Product is the Pounds Tare for the whole Commodity ; these Pounds reduc'd into Hundred weights taken from the Gross weight, leaves the Nett weight.*

Exam I. 376 C. of Sugar at 16 ℔. *per* C. Tare.

```
       16
    ------
     2256
     376     4
    ------4    C.   q.  ℔.
28)6016(214(53   2   24 Tare.
    ------  ----
     41      2
    ------              C.   q.  ℔.
     136               376   0   0  Gross,
    ------              53   2  24  Tare,
      24               -----------
    ------             322   1   4  Nett,
```

214

Note

Note I. If the Tare had been at 16 ℔. and $\frac{1}{4}$ or $\frac{1}{2}$ or $\frac{3}{4}$ *per Cw.* then having multiplied by 16 add to the Product $\frac{1}{4}$ or $\frac{1}{2}$ or $\frac{3}{4}$ of 376, and the Sum will be the Pounds Tare at that rate.

Note II. If there had been an odd quarter, half or three quarters of a *Cw.* then having multiplied by 16 you must have added to the Product the $\frac{1}{4}$, $\frac{1}{2}$ or $\frac{3}{4}$ of the Pounds Tare, which in the preceding Example was 16, the Sum will be the Pounds Tare for the whole at that rate.

Exam. II. 235 *Cw.* 1 half, at 18 ℔ 1 *q. per* C. Tare.

18
1880
235
4230
58 . 3 *q.* Tare for the 1 *q.* of a Pound.
9 . 0 Tare for the half *Cw.*
4297 . 3 *q.* whole Tare.

	Cw.	*q.*	℔.	*q*℔.
28)4297(153(4	38	1	13	3
149 1				
97				
13				

Cw.	*q.*	℔.	*q*℔.	
235	2	0	0	Gross.
38	1	13	3	Tare.
197	0	14	1	Nett.

Note

Note I. When I take the Tare for the $\frac{1}{8}$ *Cw.* which is the $\frac{1}{2}$ of 18 ℔. $\frac{1}{4}$, I neglect taking the $\frac{1}{2}$ of $\frac{1}{4}$ of a Pound, it being very insignificant in this Case.

Note II. When the Tare is the Aliquot part of a *Cw.* 'Tis truest and quickest done by taking such Aliquot part of a *Cw.* As suppose 296 *Cw.* at 14 ℔. *per Cw.* Tare. Here I consider that 14 ℔. is $\frac{1}{8}$ of a *Cw.* I there-take the $\frac{1}{8}$ of 296, it gives me 37 *Cw.* for the Tare, which I substract from 296, it leaves 259 *Cw.* for the Nett-proceed.

How to find the Trett.

Rule, *First find the Tare by the preceding Rule, which deduct from the Gross weight leaves the Subtle weight, as before was noted. Reduce this weight into Pounds, and divide by 26, the Quote is the allowance for Trett; the Pounds Trett substract from the Pounds Subtle, the Remains are Pounds Nett, which may be easily reduc'd to a Hundred weight.*

Example, 976 Hundred weight of Tobacco, Tare 13 ℔. *per* Hundredweight, and Trett 4 *p. per* 104 ℔. How many Hundred weight Nett.

I suppose the Tare found by the preceding Rule.

Cw.

Cw.	q.	lb.	
976	0	0	Gross.
113	1	4	Tare.
862	2	24	

multiplied by 4, or $\frac{1}{4}$ of 9 & 2 taken in

862 2 24 96624 lb. Subtle.
4 nett 3716 lb. ~~Nett.~~

3450 26)96624(3716(92908 lb. Nett.
28
186
27624
6900 42
96624 ps S. 164
8

28)92908(3318(829 2 4 Net weight
089 4 Cw. q. lb.
050
228
4

Note, There is a third allowance usually made for choice sort of Goods in the Port of *London* called *Clough*, which is of 2 lb. to every 3 Cw. for Draught.

More

More Examples.

436 C. $\frac{3}{4}$ of Cotton-Wool at 17 p. *per* C. Tare, how many C. Nett? *Anſ.* 370 C. 1 q. 23 p. $\frac{1}{4}$

124 C. $\frac{1}{4}$ 14 p. of Mace at 34 p. $\frac{1}{4}$ *per* C. Tare, how many C. Nett? *Anſw.* 86 C. $\frac{1}{4}$ q. 10 p. $\frac{1}{4}$.

87 Bags of Peper weight 2 C. $\frac{1}{4}$ each Tare 37 p. *per* C. how many C. Nett? *Anſwer* 131 C. 0 q. 9 p. $\frac{1}{4}$.

43 Boxes of *Caſſia* at 51 p. $\frac{3}{4}$ *per* Box Tare, how many Pounds Tare? *Anſ.* 2225 p. $\frac{1}{4}$.

17 Cask of Iron-Wyre at 23 p. $\frac{1}{2}$ *per* Cask Tare, how many Pounds Tare? *Anſwer*, 399 p. $\frac{1}{2}$.

5 Vats of Copper each 3 C. $\frac{1}{4}$ 21 p. Tare 9 p. $\frac{1}{4}$ *per* C. how many C. Nett? *Anſw.* 15 C. 3 q. 2 p. $\frac{1}{4}$.

17 Buts of Currants each 1 C. $\frac{3}{4}$ 19 p. Tare 13 p. $\frac{1}{2}$ *per* C. how many C. Nett? *Anſwer*, 28 C. 2 q. 22 p. $\frac{1}{2}$.

14 C. $\frac{3}{4}$ 16 p. of Cinnamon at 14 p. $\frac{1}{2}$ *per* C. Tare, and 4 p. *per* 104 p. Tret, how many C. Nett? *Anſ.* 12 C. 1 q. 24 p. $\frac{3}{4}$.

3 Boxes $\frac{1}{2}$ of Cloves, each 2 C. $\frac{3}{2}$, at 17 p. $\frac{3}{4}$ *per* C. Tare; and 4 p. *per* 104 p. Tret, how many C. Net? *Anſ.* 7 C. 1 q. 12 p. $\frac{3}{4}$.

1 C. $\frac{3}{4}$ of Amber-greeſe, at 47 p. $\frac{3}{4}$ *per* C. Tare, and 4 p. *per* 104 p. Tret, how many C. Net? *Anſ.* 3 q. 24 p.

$\frac{3}{4}$ 18 p. of Ginger at 30 p. $\frac{1}{4}$ *per* C. Tare, and 4 p. *per* 104 p. Tret, how much Nett? *Answer*, 2 q. 15 *near*.

The Compound Rule of Three both Direct and Inverse.

THE *compound* or *double* Rule of *Three*, is so called, because 'tis a composing of two Operations of the single Rule of Three in one, or 'tis a Resolving such Questions at one Operation, as require two of the single Rule.

In this Rule there are five distinct Numbers given to find out a sixth, in Proportion thereunto; which may be either *Direct* or *Inverse*.

Direct, When both Operations of the single Rule require a direct Proportion, as in this *Example*.

if 30 *If* 38 *Soldiers spend* 228 *l. in* 16 *Weeks? How much will serve* 50 *Soldiers for* 12 *Weeks?*

Inverse, When one of the Operations of the single Rule requires an inverse Proportion, as in this *Example*.

If

If 20 Acrees Graze 32 Oxen for 18 Days? How many Days will 30 Acrees last 40 Oxen?

The three first Terms in this Rule express a Supposition, as in Question the first, (If 38 Soldiers spend 228 l. in 16 Weeks) the two last a Demand, as, (*How much will serve 50 Soldiers for 12 Weeks?*)

So also in Question the second, (*If 20 Acrees Graze 32 Oxen for 18 Days*) is the Supposition, and (*How many Days will 30 Acrees last 40 Oxen*) the Demand.

To state the Question in the direct Rule, *Let the first and fourth Terms be of one Name or Nature; as also, the second and fifth; and the third Term must be like unto the Term required, which is the sixth; or thus, that of the three Terms implying a Supposition, which is like the sixth or term required, must be the third Term in the stating, and the remaining two, make the first and second Terms: It matters not which is which; lastly the two, which express the Demand, let be the fourth and fifth Terms; not heeding which of the two you put in the fourth or fifth place.*

The Question being stated according to either of these Directions, *Divide the product of the third, fourth and fifth Terms, by the product of the first and second Term; the quote is the answer to the Question.* See the

following Method of ſtating and working the preceding Queſtion.

Sold.	W.	l.	Sold.	W.
If 30 *in*	16 *ſpend*	228 *what will*	50 *ſpend in*	12

$$
\begin{array}{rr}
30 & 50 \\
\hline
480 & 11400 \\
\hline
 & 12 \\
\hline
\end{array}
$$

$480)136800(285$ *l. Anſw.*

In the Compound Rule of Three Inverſe, *Obſerve among the Terms of Suppoſition, which of them hath the ſame Denomination with the Term required, and reſerve that for the ſecond Place; then ſet the other two Terms of the Suppoſition one above another in the firſt Place; and laſtly, the Terms of demand one above another in the third Place of the ſtating, in ſuch ſort, that the uppermoſt in the third may be of the ſame Name, with the uppermoſt in the firſt Place.* For Example.

The

The preceding Question is thus stated.

A.	D.	A.
20	18	30
ox		ox
32		40

Or thus.

ox	D.	ox
32	18	40
20		30

The Question being thus stated, *Multiply the uppermost Term in the first Place, by the lowermost Term in the last; and the uppermost of the last, by the lowermost of the first; setting each product under the lower Term, by which it is produc'd.*

If then, the Inverse Proportion be in the upper Line, using these products as single Terms, *Proceed to find the Term required by the single Rule of Three Direct.* But in case you find the Inverse Proportion in the lower Line, *Perform the work by the single Rule of Three Reverse.* See the following Operations.

20
40
800

32
30
960

multiply'd
cross way

20——————18——————30
32——————————————40

960　　　　　　　　800
18

7680
96

Days.

800)17280(21 . $\frac{48}{80}$ *Answ.*

Or thus it may be operated.

32———18———40
20—————————30

800　　960
　　　　18

7680
96

Days.

800)17280(21 $\frac{48}{80}$ *Answ.*

The Proof of either of these Rules is perform'd by a back Stating, as were those of the single Rule of Three both *Direct* and *Inverse.*

Examples *in the Direct Rule.*

If 50 C. weight carried 35 Miles cost 48 £ what will the Carriage of 30 C. weight cost 138 Miles? *Answer,* 113 *l.* 11 *s.* 1 *d.* $\frac{1}{35}$.

If

If when the Bushel of Wheat is sold for 7 *s.* I can Board 9 Men for 42 Shillings. How much will pay the Board of 36 Men, when Wheat is sold for 5 *s.* 6 *d.* the Bushel? *Answ.* 7 *l.* 8 *s.*

Examples *in the Inverse Rule.*

If 36 Crowns in 10 Months gain 24 Shillings, in how many Months will 150 Crowns gain 80 Shillings? *Answer*, 80 *Months.*

If 765 Yards of Cloath of $\frac{3}{4}$ broad, Clothe 100 Men, how many Men will 150 Yards of 7 quarters broad serve? *Answer*, 45 *Men.*

Of Interest Simple and Compound, with the Valuation of Annuities and Pensions in Reversion.

TO say all that might be said of this subject would make a large Volume, I shall therefore only give some short practical Rules for doing of these Things.

In order to this, I must acquaint my Reader, That *Principal Money*, is the Mo-

ney put out to Intereſt; *Intereſt Money*, is the *Loan*, *Præmium*, or *uſe Money*, paid for the uſe of ſuch Principal.

Intereſt, is *Simple* or *Compound*; *Simple*, when the Intereſt of the ſum firſt Lent is only paid; *Compound*, when the Intereſt not only of the ſum firſt Lent, but alſo of ſuch Intereſt as is not paid when due. For *Example*, Suppoſe 100 *l.* be Lent out for a Year for 6 *l.* then at the ſecond Years end I reckon compound Intereſt, which is the Intereſt of the 100 *l.* and of the 6 *l.* that ſhould have been paid for the Intereſt of the 100 *l.* for the firſt Year.

Rate of Intereſt, is the Money that is paid for the Intereſt of 100 *l.* for one Year; and from this *Rate*, the Intereſt of any other Sum for any other time is computed.

Sect. 1. *Simple Intereſt*, Queſtions in Simple Intereſt may be wrought ſeveral Ways: As by the ſingle Rule of Three at 2 Operations; or, part by the Rule of Three, and part by Practice, and ſome oth rs: I ſhall give an *Example* wrought theſe two Ways.

But before I proceed, take this Rule for ſtating the Queſtion, if the time be longer or ſhorter than a Year, and the Sum more or leſs than 100 *l.* *The firſt Term muſt be 12 Months, or 365 Days; the ſecond Term the rate of Intereſt; and the third the time propoſed; working this by the Rule of Three,* a

a Facit *comes out. Then ſay, if* 100 *l. gives that* Facit, *what ſhall the propoſed Sum give, working here as before; there will come out the Intereſt of the given ſum, for the time required.*

Example 1. What's the Intreſt of 240 *l.* 10 *s.* for 9 Months at 6 *l.* *p. Cent. p. Ann.*

First, *By the ſingle Rule of Three.*

Say. If 12 Mon. give 6 *l.* what ſhall 9 Mon.

```
         20
        ----
        120 s.
          9
        ----
    12)1080(90 s.
             ----
            4 l. 10 s. Facit.
```

This 4 *l.* 10 *s.* that comes out is the Intereſt of 100 *l.* for 9 Months; and therefore, if 100 *l.* give 4 *l.* 10 *s.* what ſhall 240 *l.* 10 *s.* give.

```
  20                    20
 ----                  ----
 2000 s.               4810 s.
                         90
                       ----
 2000)432900(216 s. 9/20 Anſ.
 Or, 10 l. 16 s. 5 d. 1/5 near.
```

qu-10389
2
2597-1
12
216-5
210
10:16:5:4

Secondly,

Secondly, *By the single Rule of Three and Practice.*

If 12 Months give 6 *l.* what shall 9 Months? *Answ.* 4 *l.* 10 *s.* as before.

Then say 240 *l.* 10 *s.* at 4*l.* 10 *s. p.* C. pound

```
              4
           ------
           962.0
           120.5
           --------
£      10 | 82.5
          | 20
           --------
s —    16 | 45
          | 12
           --------
d —     5 | 40
          |  4
           --------
q —     1 | 60
           --------
```

The Figures cut off to the left, being 10 *l.* 16 *s.* 5 *d.* ½ *near*, is the Interest of 240 *l.* 10 *s.* for 9 Months.

The Reason of this last Operation is thus, having found the Interest of 100 *l.* for 9 Months, which is 4 *l.* 10 *s.* say, as in the

the first Way, if 100 *l.* give 4 *l.* 10 *s.* what shall 240 *l.* 10 *s.* give. Here I am to Multiply the second Term by the third, and divide by the first, which in this second Case I do practically. For first, I multiply 240 *l.* 10 *s.* by 4, it makes 962 *l.* then, because I have 10 *s.* more in the Multiplior, which is the half of one pound; I therefore take the half of 240 *l.* 10 *s*, which is 120 *l.* 5 *s.* and place under the 962 *l.* the sum of these which is 1082 *l.* I divide by 100, which is done by cutting off two Figures to the Right-hand, so are those on the left Pounds; the 82 cut off is part of a pound, and must be multiplied by 20 to bring it into Shillings; this done, I divide by 100, that is, I cut off two Figures to the Right, again the Figures on the Left are Shillings. The 45 cut off I multiply by 12, and cut off two Figures to the Right, as before; the Figure or Figures on the Left are Pence, the 40 cut off I multiply by 4, and cut from the Product two Figures as before; the Figures on the Left is Farthings, and the remainder $\frac{60}{100}$ or $\frac{6}{10}$ of a Farthing; which, because is something more than half a Farthing, I make the Farthing last cut off a Half-penny: So that the Interest of 240 *l.* 10 *s.* for 9 Months, is 10 *l.* 16 *s.* 5 *d.* $\frac{1}{2}$ *near*, being the same as it came to before.

Notes,

Notes 1. If the Intereſt of any Sum of Money be requir'd for one Year, one Stating does it, For 100 *l.* is to 6 *l.* as any given Sum is to its Intereſt for one Year. So alſo the Intereſt of 100 *l.* for any time above or under a Year is found at one Stating; *thus*, if one Year give 6 *l.* what ſhall any other time give.

2. If the Intereſt of any Sum be required for a Quarter, half, or three Quarters of a Year, one Stating does it, for having found the Intereſt for a Year, Take $\frac{1}{2}$, $\frac{1}{3}$ or $\frac{3}{4}$ thereof, and it will be the Intereſt of the propoſed Sum for ſuch part of a Year.

3. If the Intereſt of any Sum be required for Days, then inſtead of 12 Months, ſet 365, the Days in one Year; *that is*, as 365 Days to 6 *l.* ſo is any other Number of Days to a fourth Proportional, which is the Intereſt of 100 *l.* for ſuch Number of Days.

I shall conclude this Section *with two of the shortest Rules, for finding the Simple Interest of all Sums, for any Rate, and any Time.*

Rule the First. *Multiply the Sum given by the Rate, and the Product by the Number of Days; this second Product divide by 365, and the Quote will answer the Question.*

Rule the Second. *Multiply the Sum proposed by the Number of Days, and that Product again by the Interest of one Pound for one Day; the Product is the Answer.*

Notes 1. The Exercise of these Rules is best performed in Decimals.

2. The *Rate* here meant is the Interest of one Pound for one Year, found by saying, if 100 *l.* give 6 *l.* what shall 1 *l.* give? Here adding two Cyphers to the 6, and dividing by 100, the Quote, according to Decimal Division, will be .06 of a Pound, after this Method you'll find.

If the Intr. be at	4	*p. cent. p. An.*	the Rate will be	.04	of a Pound.
	5			.05	
	6			.06	
	7			.07	
	8			.08	

3. When

3. When Shillings, Pence or Farthings, happen to be joined with any Number of Pounds, they must be reduced to the Decimal parts of a Pound, and so set to the Pounds with a point of Seperation, which business is very readily Effected, by having in mind the brief way of valuing a Decimal, mentioned in *page* 105.

4. The Interest of 1 *l.* for one Day, is found after the same manner, as is the Interest of 240 *l.* 10 *s.* in the first *Example* of this *Section*, by which method you will find

The Intr.	4	.0001095890	
of 1 *l.* for	5	.0001379863	
1 day, after the	6 *p.Cent.p.An.*	.0001643835	of a Pound.
rate of	7 to be——	.0001917808	
	8	.0002191781	

This being premised, I shall give an Example, which shall be wrought by both these Rules.

Exam. 1. What's the Interest of 721 *l.* 10 *s.* for 274 Days, at the rate of 6 *l. p. Cent. p. An.*

By

£ s d
721: 10 0
principall

By the First Rule.

```
 721 l. 5
      .06 Rate.
 ---------
 43.290
     274 Time.
 ---------
  173160
 303030
 86580
 ---------
365)11861460(32 l. 497 Answ.
      911 Or 32 l. 9 s. 11 d. 1/4 near.
     1814
     3546
      2610
        55
```

By

By the Second Rule.

£ s
721:10

.0001643835 Intr. of 1 *l.* for 1 day.
721.5 Principal.

8219175
1643835
3287670
11506845

1186026952$5$
274 Time.

474410781$00$
830218866$75$
237205390$50$

32.497138498$50$ *Answ.*

Or 32:9:11 ¼ *near* as before.

Note, 'Tis no matter which of the Terms you Multiply First, and therefore for Conveniences sake, I put that first, which has the most Figures in it; *that is*, I make that the Multiplicand, which has most Places.

More

More Examples.

What's the Intereſt of 1768 *l.* 15 *s.* 10 *d.* for two Years and three Months, at 6 *l. per Cent. per Ann?* *Anſwer*, 238 *l.* 15 *s.* 8 *s.* $\frac{1}{4}$ *near.*

What's the Intereſt of 896 *l.* 14 *s.* 2 *d.* $\frac{1}{2}$ for 256 Days, at 6 *l. per Cent. per Ann?* *Anſwer*, 38 *l.* 3 *s.* 11 *d. near.*

What's the Intereſt of 1000000 *l.* for one Day, at 7 *l. per Cent. per Ann?* *Anſw.* 191 *l.* 15 *s.* 07 *d.* $\frac{1}{4}$ *near.*

Sect. 2. *Rebate or Diſcompt.* According to Simple Intereſt, is to find how much preſent Money will ſatisfy a Debt to be paid hereafter at any Rate, *per Cent. per Ann.*

For Inſtance. The preſent Money that will ſatisfy a Debt of 106 *l.* due one Year hence, at 6 *l. per Cent. per Ann.* is 100 *l.* *The Reaſon is clear*, for 100 *l.* put out for one Year will amount to 106 *l.* at the Year's end, after the rate of 6 *l. per Cent. per Ann*; So that 100 *l.* is the preſent Money that muſt be paid, and 6 *l.* the Rebate or Diſcompt, for ſuch prompt Payment. 100

And therefore 100 *l.* ready Money is equal in value to 106 *l.* to be paid one Year hence.

Now for ſolving of Queſtions in this Rule, take the following Direction.

The first Term must be 12 Months, the second the Rate of Interest, and the third Term the time proposed, working this by the direct Rule of Three, a Facit *comes out; this* Facit *add to 100 l. and make that the first Term in this second Stating, 100 l. the second Term; and the proposed Sum the third. Working this as before, there will come out the Answer, which is the present Money that must be paid.*

Exam. What present Money must be paid for 210 *l.* due 8 Months hence, Rebating 6 *l. per Cent. per Ann.*

Say, If 12 Mon. give 6 *l.* what shall 8 Mon. give.

8

12)48(4 *l. Answ.*

Thus, If 104 pay 100 *l.* what shall 210 *l.* pay.

100

104)21000(2~~0~~0*l.* $\frac{96}{104}$ *Answ.*

200

104

quære this — 96 Or 2~~0~~0*l.* 19 *s.* 2 *d.* ½ near.

£ s d

2~~0~~0 : 18 : 4

as I make it

More

More Examples.

What's the Rebate of 375 *l.* 15 *s.* 06 *d.* for 217 Days, after the Rate of 7 *l. per Cent. per Ann?* *Answ.* 15 *l.* 00 *s.* 3 *d.* $\frac{1}{4}$ *near.* — 15 — 12 — 9 I make this

Suppose 2000 *l.* be to be paid 50 Years hence, what is it worth in ready Money, discompting after the Rate of 6 *l. per Cent. per Ann?* *Answ.* 500 *l.*

What's a Legacy of 500 *l.* worth to be paid 99 Years hence, discompting after the Rate of 5 *l. per Cent. per Ann?* *Answ.* 84 *l.* 00 *s.* 08 *d. near.*

Sect. 3. *Equation of Payments.* The design of this Rule was to teach how to reduce the times for Payment of several Sums of Money, to one time for Paying of the whole Debt, without Injury to Debtor or Creditor.

For doing of which this is the Rule. *Multiply the Sum of each particular Payment by its respective time; then add their several Products together; the Total divide by the whole Sum of Money; the Quote is the equated time for the Payment of the whole Debt.*

But Note. The times of payment if not so given, must be reduc'd to one Denomination; that is, they must be all Years,

 Months,

Months, &c. And then the Quote will accordingly be Years, Months, &c.

This premis'd, I ſhall proceed to ſhow the Falacy of this Rule, as ſome *Authors* before me has already done; and therefore, I have inſerted it, more for Variety, than for Uſe.

Exam. Suppoſe 105 *l.* to be paid at the end of 12 Months, and 210 *l.* at the end of 24 Months, What's the equated time for Paying all at once, ſo that neither Debtor nor Creditor may be damnified?

In this Caſe, as in all others of this Nature, ſome Rate of Intereſt muſt be implied, elſe any Day at pleaſure may be aſſign'd.

Let therefore the rate of 5 *per Cent. per Ann.* be underſtood in the preceding Queſtion, then reaſon will require that the preſent worth of the Total Sum payable at once, (Rebate being made according to the aſſign'd Rate of Intereſt) muſt be equal to the Sum of the preſent worths of the particular Sums; Rebate being made at the ſame Rate of Intereſt, which ſhall be Examin'd in the following Operation of the preceding Queſtion.

105 *l.*

210
24
840
420
5040

105
12
1260
5040
6300

105 *l.* at 12 Mon——1260	
210 *l.* at 24 Mon——5040	
315	6300

315)6300(20 Mon. the time for payment of the whole at once.

And here Note, That had the Rate *per Cent. per Ann.* been 6, 7, 8, or any other, The equated Time would have been the same.

So the equated Time for payment of the whole Sum, *viz.* 315 *l.* at once, is found to be 20 Months, according to this Rule.

Now the present worth of 315 *l.* to be paid 20 Months hence, according to the preceding Rule of Rebate is 290 *l.* 15 *s.* 5 *d. near*, at 5 *l. per Cent. per Ann.*

And the present worth of 105 *l.* to be paid 12 Months hence, rebating 5 *per Cent. per Ann.* is 100 *l.* and the present worth of 210 *l.* to be paid 24 Months hence at the aforesaid, is 190 *l.* 18 *s.* 2 *d. near.* The Sum of these two present worths make 290 *l.* 18 *s.* 2 *d.* which is more than the former by near 2 *s.* 8 *d.* And showeth that the Creditor, or he that receiveth the whole Sum at the end of 20 Months,

 loseth

loseth near 2 *s.* 8 *d.* which shows that the Rule is False.

But tho' the common way of working Questions in this Rule is false, yet, when there is occasion for the Solution of such Questions, he that will take the pains may find out a *mean time*, at any Rate of Simple Interest. *Thus,*

Find the present worth of every particular Sum in the Question payable at a time to come, by Sect. 2. *Then find in what time the Sum of these present worths will be encreased to the Total of all the particular Sums due, or payable at Times to come, and that will be the true equated Time for payment of the whole Debt.*

Sect 4. *Annuities at Simple Interest.* The Business of computing the amount, or present worth of an Annuity at Simple Interest by common Arithmetick, is as troublesome to Work as 'tis Ridiculous and Useless. Because, as shall be showen hereafter, (in the Demonstrative Part of this Treatise) the present worth of an Annuity computed according to Simple Interest may amount to 200 Years purchase, which is more by $\frac{4}{5}$ than is commonly given for any Annuity or *Pension* here in *England.*

But altho' for the reason before mentioned, the Computation of the amount, or present worth of an Annuity or Pension after this manner be Useless; yet, because other Authors have given Rules for the Solution

lution of ſuch Caſes ; I ſhall alſo in the following *Tract* of *Demonſtration* ſhow how to erect a general *Theorem* for doing the ſame, and alſo how ſome Authors have miſtaken in the Rules they have given upon this occaſion; particularly Mr. *Kerſey* in his *Appendix* to *Wingate*'s *Arithmetick*, and Dr. *Newton* in his *Scale* of *Intereſt*, *page* the 20th, and therefore I ſhall ſay no more of it in this place.

Sect. 5. *Compound Intereſt*, or *Intereſt upon Intereſt*. When 'tis required to know what Sum of Money any principal, forborn any Number of Years, will be encreaſed unto, Intereſt upon Intereſt being reckoned at a given Rate. 'Tis done by ſaying, if 100 *l.* amount to 106 in a Year, what ſhall one pound amount to, working this by the *Rule* of *Three Direct*? You'll find 1.06 for the anſwer ; So that at the Rate of 6 *l. per Cent. per Ann.* the amount of 1 *l.* for 1 Year is 1. 06, which Sum in this Caſe is call'd the Rate. Then ſay, if 1 *l.* give 1. *l.* 06 what ſhall 1. 06 ? The *Anſwer* 1. 1236, is found by Multiplying 1. 06, by 1. 06 the amount of 1 *l.* at two Year's end. Then Multiply 1. 1236 by 1. 06, 'twill give 1. 191016 the amount of 1 *l.* forborn 3 Years ; again, if you Multiply this laſt Product by 1. 06, 'twill give 1. 26247696 the amount for 4 Years ; *and ſo on.*

This done, *say*, if 1 *l.* give this amount for 4 Years, what ſhall any other Sum give, here working by the Rule of Three Direct? There will come out the amount of the propoſed Sum.

From a ſerious Conſideration of what foregoes there ariſes this general Rule, for ſolving of Queſtions in *Compound Intereſt*.

Rule. *Involve or Multiply the Rate ſo often into it ſelf, as is the Number of Payments wanting* 1. *The Product Multiply by the propoſed Principal, and the Reſult will give you the amount of the Sum propoſed.*

Exam. What's the amount of 89 *l.* 10 *s.* forborn 4 Years, at 6 *l.* *per Cent.* *per Ann.* computing *Compound Intereſt*.

1.06 amount of 1 *l.* for 1 Year.
1.06

636
1060

1.1236 amount of 1 *l.* for 2 Years.
1.06

67416
112360

1.191016 amount of 1 *l.* for 3 Years.
106

7146096
11910160

1.26247696 amount of 1 *l.* for 4 Years. £ s d
895 — 895, decimally is — 89 – 10 – 0

631238480
1136229264
1009981568

112.991687920 amount sought.

So that according to this Method, the amount of 89 *l.* 10 *s.* forborn 4 Years, is 112 *l.* 19 *s.* 9 *d.* $\frac{3}{4}$ *near.*

After

After this Method is Calculated the following Table, shewing the amount of 1 *l*, forborn any Number of Years under 21, at the rate of 5, 6, or 7 *per Cent*. which may be carried on to any Number of Years that you please.

A Table showing the amonut of 1 *l*. forborn any Number of Years under 21. at the Rates of 5, 6, and 7 *per Cent. per Ann.* Compound Interest.

Years.	5	6	7
1	1.05000	1.06000	1.07000
2	1.10250	1.12360	1.14490
3	1.15762	1.19101	1.22505
4	1.21550	1.26247	1.31080
5	1.27628	1.33822	1.40255
6	1.34009	1.41851	1.50073
7	1.40710	1.50363	1.60578
8	1.47745	1.59384	1.71818
9	1.55132	1.68947	1.83845
10	1.62889	1.79084	1.96715
11	1.71033	1.89829	2.10485
12	1.79585	2.01219	2.25219
13	1.88564	2.13292	2.40984
14	1.97993	2.26090	2.57853
15	2.07892	2.39655	2.75903
16	2.18287	2.54035	2.95216
17	2.29201	2.69277	3.15881
18	2.40661	2.85433	3.37993
19	2.52695	3.02559	3.61653
20	2.65329	3.20713	3.86968

The

The use of the Table is thus, The top Row shows the Rates of 5, 6, and 7 *per Cent.* The left side Column the Number of Years, and the Angle of meeting, the amount of 1 *l.* forborn so many Years, and at such a rate of *Compound Interest.*

For an Instance, take the foregoing Question, What's the amount of 89 *l.* 10 *s.* forborn 4 Years, at 6 *l. per Cent. per Ann.*

Seek in the upper Row for 6 *l.* the Rate of Interest given, and in the left side Column for 4 Years, then at the Angle of meeting is 1. 26247 the amount of 1 *l.* forborn 4 Years at the Rate a foresaid. This Multiply'd (as aforedirected) by the given Principal, *viz.* 89 *l.* 10 *s.* will give 112 *l.* 19 *s.* 9 *d.* $\frac{3}{4}$ *near,* the amount of 89 *l.* 10 *s.* forborn 4 Years, at the Rate of 6 *l. per Cent. p. Ann. Compound Interest.*

1 0 9
1 - 5 3, or 2 $\frac{3}{4}$

Notes 1. Having got the amount of any Sum, substract the Principal there from, and the remainder is the Interest upon Interest of such Sum.

2. If the Interest be at 4, 5, 7, 8, &c. *per Cent. per Ann.* then the Rate will be 104, 105, 107, 108, &c. and is found by the preceding Direction.

3. If the Payments are Yearly, then if there is an odd half Year, the last amount must be Multiplied by the Square Root of the Rate. If an odd Quarter by the Biquadrate Root of the Rate; and if there be odd Days, then by the 365th Root of the Rate.

More Examples.

169-5-5
I judge

What's the Interest upon Interest of 500 *l.* forborn 5 Years at 6 *l. per Cent. per Ann. Compound Interest? Answ.* 169 *l.* 2 *s.* 3 *d. near.*

What's the amount of 3650 *l.* 10 *s.* forborn 7 Years and $\frac{1}{2}$, at 5 *l. per Cent. per Ann. Compound Interest? Answer,* 5552 *l.* 11 *s.* 1 *d.* $\frac{1}{4}$ *near.*

Sect. 6. But suppose a Sum of Money due hereafter, and 'tis required to know what present Money will satisfie the same, computing after any Rate of *Compound Interest? 'Tis done thus,*

Find a series of Geometrick Propotionals one more in Number, than the Number of Years mentioned, decreasing from the Sum to be rebated in such Proportion as 100 *Degrees, from* 100 *added to the Rate of Interest; the last of these Proportionals shall be the present Money Demanded.*

Exam. What's the present worth of 520 *l.* to be paid 4 Years hence, discompting after the

1st year — 490: 11: 3: 3/4
2d yr — 462: 14: 11: 1/4
3d yr — 436: 12: 0
4th yr — 411: 17: 9: 3/4

the Rate of 6 *l.* *per Cent.* *per Ann.* *Compound Interest?*

Say, if 106 give 100 *l.* what shall 520 give? The *Answer*, is 490. 566, this is what is due at the 3d Year's end. Then again, if 106 give 100 *l.* what shall 490. 566? The *Answer*, is 462. 79 and so much is due at the end of second Year. Proceed thus with the rest, and you'll find the 5th Proportion to be 411. 888 or 411 *l.* 17 *s.* 9 *d.* which is the present Money that will satisfy the aforesaid Debt.

But the present worth of any Sum of Money due hereafter, is more readily discovered by the foregoing Table. *Thus*, Find the amount of 1 *l.* for the time, and at the Rate proposed by which divide the Principal, the Quote is the present worth of the said Principal.

note money due hereafter find by ye table of Amount & worth by ye rule of 3

Let the preceding Example be proposed. What's the present worth of 520 *l.* due 4 Years hence, discompting after the Rate of 6 *l.* *per Cent.* *per Ann.* *Compound Interest.*

Here I divide 520 by 1. 26247 the amount of 1 *l.* for the time proposed; the Quote 411. 890 *near*, is the present worth as before of 520 *l.* to be paid 4 Years at 6 *l.* *per Cent.* *per Ann.* *Compound Interest.*

l s d
411–17–9 1/2

Sect. 7. Of Annuities and Pensions in Reversion at *Compound Interest*. The method of valuing Annuities and Pensions, after this manner,

manner, depends upon finding the present worth of any Sum for *One*, *Two*, *Three*, or more Years; the Sum of which present worths, is the present worth of the Annuity.

But First. To find the amount of an Annuity or Pension in arrear, allowing a certain Rate of *Compound Interest*. *Do thus*,

Find a series of Geometrick Proportionals, whose first Term let be the Annuity, and the Ratio, as 100 *to* 100 *added to the Interest of* 100 *l. That is, if the Rate be at* 6 *l.* per Cent. *'twill be as* 100 *to* 106, *the Sum of these Proportionals shall be the amount of the Annuity or Pension so forborn.*

Now to make the Operation more universal and easie, Reduce the Rate of 100 to 106 to another Rate equal thereto; whose first Term let be 1. (as was taught in *Compound Interest*) thus, if 100 give 106, what shall 1 give? *Answer*, 1. 06. So that 1. 06 is the common *Ratio* of all the Terms.

Exam. An Estate of 150*l.* is left to an Heir of 17 Years of Age, what must he receive at the Age of 21 Years, at the Rate of 6 *l. per Cent. per Ann. Compound Interest.*

First,

First, Because the Time is 4 Years to make him of Age, 'tis Evident there must be computed the amount of 150 *l.* for three Years.

Secondly, There must be computed the amount of 150 *l.* for two Years, which is the Rent due at the end of the second Year.

Thirdly, There must be computed the amount of 150 *l.* for one Year, which is the Rent due at the third Year's end.

Lastly, The Annuity it self, which is the Rent due at the fourth Year's end, for which no Interest is to be reckoned, the Sum of these four Amounts, is the amount of the Annuity. See the Operation of the preceding *Example*,

$$1 : 1,06 \begin{cases} 150 : 159 \\ 159 : 168,54 \\ 168.54 : 178.6524 \end{cases}$$

150.

656,1924

So

So that by the foregoing Work, I find the amount of 150 *l. per Ann.* lying unpaid for 4 Years to be 656 *l.* 3 *s.* 10 *d.* $\frac{1}{4}$ *near*, at the rate of 6 *l. per Cent. per Ann.* Compound Interest.

After this manner of Proceeding may the following be Constructed, which shows the amount of 1 *l.* Annuity to continue any Number of Years under 21, at the Rates of 5, 6 and 7 *per Cent. per Ann.* Compound Interest being reckoned.

$$100 : 106 \begin{cases} 1 \text{———————to } 1.06 \\ 1.06 \text{————--to } 1.1236 \\ 1.1236 \text{——to } 1.191016, \&c. \end{cases}$$

The Operation is for 6 *l. per Cent. per Ann.* And from it 'tis Evident, 1 must be the first Number in the following Table, and 1 + 1.06 the second; and 1 + 1.06 + 1.1236 the third, and so on. After which Method you may Calculate a Table, that shall show you the amount of 1 *l.* for as many Years as you please.

A

A Table shewing the amount of 1 *l.* Annuity for any Number of Years under 21, at the Rate of 5, 6 and 7 *per Cent. per Ann.* Compound Interest.

Years	5	6	7
1	1.00000	1.00000	1.00000
2	2.05000	2.06000	2.07000
3	3.15250	3.18360	3.21490
4	4.31012	4.37461	4.43994
5	5.52563	5.63709	5.75073
6	6.80191	6.97531	7.15329
7	8.14200	7.39383	8.65402
8	9. 64910	9. 89746	10.25980
9	11.02656	11.49131	11.97798
10	12.57789	13.18079	13.81644
11	14.20678	14.97164	15.78359
12	15.91712	16.86994	17.88845
13	17.71298	18.88213	20.14064
14	19.59863	21.01506	22.55048
15	21.57856	23.27596	25.12902
16	23.65749	25.67252	27.88805
17	25.84036	28.21287	30.84021
18	28.13238	30.90567	33.99909
19	30.53900	33.75999	37.37896
20	33.06505	36.78559	40.99549

Use of the preceding Table.

Suppose an Annuity to continue any Number of Years under 21 to find its Amount, *Do thus*, look the Years of continuance on the Left-side of the Column, and the Rate at Top. Then at the Angle of meeting is the amount of 1 *l.* Annuity to continue the Time, and at the rate proposed, this Multiplyed by the proposed Annuity, gives the amount of the said Annuity.

I judge it 90 *Exam.* An Annual Pension of 90*l. per Ann.* is in Arrear for 12 Years, what doth it amount to at 6 *l. per Cent. per Ann. Compound Interest.*

Against 12 Years in the Left-Column under 6 *l.* the rate *per Cent.* I find 16.86994 the amount of 1 *l.* in 12 Years; This I Multiply by 90, it gives 1518.295 or 1518 *l.* 05 *s.* 11 *d. near*, and so much is the amount of 90 *l.* forborn 12 Years.

.294 — 5 : 10 : 3/4

Sect. 8. If you would find the present worth of an Annuity to continue any Number of Years; that is, how much ready money will purchase it, allowing the Purchaser a certain rate of Compound Interest. *Proceed thus,*

Find a Rank of continued Geometrick Proportionals, (one more in Number, than the given

ven Term of Years) decreasing from the proposed Annuity in such Proportion, as 100 *doth from* 100 *added to the Interest of* 100 *l. That is, if the Rate be at* 6 *l.* per Cent. *'twill be as* 106 *to* 100. *The Sum of these Proportionals excepting the first, (which is the given Annuity) is the price, or present worth, of the proposed Annuity.*

Exam. Suppose an Annuity of 50 *l. per Ann.* to continue 4 Years, what is it worth in ready Money, discompting after the rate of 6 *l. per Cent. per Ann. Compound Interest.*

Here, as in the foregoing Rule you must find the present worth of 50 *l.* for One, two, three and four Years, and add them together, the Sum is the present worth of 50 *l.* to continue 4 Years. See the following Operation,

$$\text{as } 106 : 100 \begin{cases} 50. & : 47.169 \\ 47.169 & : 44.499 \\ 44.499 & : 41.971 \end{cases}$$
$$41.971 \quad : 39.5$$
$$\overline{173.139}$$

By which I find the present worth of an Annuity of 50 *l.* to continue 4 Years at 6 *l. per Cent. per Ann.* to be 173 *l.* 2 *s.* 9 *d.* reckoning *Compound Interest.*

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(165)

After this manner of Proceeding may the following Table be Constructed, which shows the present worth of 1 *l.* Annuity to continue any Number of Years under 21, rebate being made at the Rates of 5, 6 and 7 *per Cent. per Ann. Compound Interest.* By saying,

$$\text{as } 106 : 100 \left\{ \begin{array}{ll} 1 & : 952381 \\ .952381 & : 907029 \\ .907029 & : 863837 \\ .863837 & : 122702, \text{ \&c.} \end{array} \right.$$

The preceding Operation is for 6 *l. per Cent.* and 'tis Evident from it, that .952381 must be the first Number in the following Table; and .952381 + .907029 the second: And so proceeding may you make a Table, that shall show you the present worth for as many Years as you please.

This

This Table ſhews the preſent worth of 1 *l.* Annuity to continue any Number of Years under 21, rebate being made a 5, 6, and 7 *per Cent. per Ann. Comp. Int.*

Years.	5	6	7
1	.95238	.94330	.93457
2	1.85941	1.83339	1.80801
3	2.72324	2.67301	2.62431
4	3.54595	3.46510	3.38721
5	4.32947	4.21236	4.10019
6	5.07569	4.91732	4.76653
7	5.78637	5.58233	5.38928
8	6.46321	6.20979	5.97129
9	7.10782	6.80169	6.51523
10	7.72173	7.36008	7.02358
11	8.30641	7.88687	7.49867
12	8.86325	8.38384	7.94268
13	9.39357	8.85268	8.35765
14	9.89864	9.29498	8.74546
15	10.37965	9.71224	9.10791
16	10.83776	10.10589	9.44664
17	11.27406	10.47725	9.76322
18	11.68958	10.82760	10.05908
19	12.08531	11.15811	10.33559
20	12.46220	11.46992	10.59401

Use of the preceding Table.

Suppose the present worth of an Annuity to continue any Number of Years under 21 be requir'd. Seek the Years in the left side of the Column, and the rate of Interest at top: And in the Angle of meeting is the present worth of 1 *l.* Annuity to continue for the Years, and at the rate of Interest proposed, by which Multiply any other Annuity, 'twill give the present worth of it at the aforesaid Time and Rate.

Exam. What's the present worth of 100 *l.* Annuity to continue 9 Years, computing after the rate of 6 *l. per Cent. per Ann. Compound Interest?*

Against 9 Years in the left Column, and under 6, the rate *per Cent.* I find 6.80169 the present worth of 1 *l.* Annuity to continue 9 Years.

This Multiply by 100, it gives 680. 16900, which is 680 *l.* 3 *s.* 4 *d.* ½ *near.* and so much is the present worth of 100 *l. per Ann.* to continue 9 Years, computing after the rate of 6 *l. per Cent. per Ann. Compound Interest.*

Sect. 9. If you would know what Annuity or Pension, any Sum of Money will pur-

purchase to continue any Number of Years, and at any rate of Interest. *Do thus,*

Find the present worth of 1 *l. Annuity to continue the Number of Years, and at the Rate of Interest given; then 'tis Evident, if the Sum so found be the present worth of* 1 *l. Annuity; such Sum will purchase one pound Annuity for the time, and at the rate proposed.*

Then say by the Rule of Three. *If that Sum Purchase* 1 *l. Annuity for the time, and at the Rate mentioned; what shall any other Sum purchase?*

Exam. I would know what Annuity to continue 7 Years, 500 *l.* will Purchase after the rate of 5 *l. per Cent. per Ann. Compound Interest.*

By the preceding Table, I find, the present worth of 1 *l.* Annuity to continue 7 Years, 5 *l.* 15 *s.* 8 *d.* $\frac{3}{4}$ *near.* Then if 5 *l.* 15 *s.* 8 *d.* $\frac{3}{4}$ Purchase 1 *l.* Annuity to continue 7 Years, what shall 500 *l.* Purchase? The *Answer.* Is 86 *l.* 8 *s.* 2 *d.* $\frac{1}{4}$ *near,* and so much is the Annuity, that 500 *l.* will Purchase to continue 7 Years, after the rate of 5 *l. per Cent. per Ann. Compound Interest.*

More Examples.

1. What's the present worth of an Annuity of 20 *l. per Ann.* to continue 10 Years, rebating 6 *l. per Cent. per Ann. Compound Interest?*

 147:3:9

Intereſt? *Anſwer*, 92 *l.* 1 *s.* 10 *d.* *near.* by *Section* 8. 9 judges 147:3:9:

2. What Annuity will 600 *l.* Purchaſe, to continue 9 Years after the rate of 7 *l. per Cent. per Ann. Compound Intereſt?* *Anſwer*, 92 *l.* 1 *s.* 10 *d. near*, by *Section* 9.

I make it 92:2:1:

3. An Annuity to continue 18 Years is to be ſold for 7600 *l.* what will it let for *per Ann.* to bring in Principal and Intereſt, computing after the rate of 6 *l. per Cent. per Ann. Compound Intereſt?* *Anſwer*, 701 *l.* 18 *s.* 2 *d.* ½ by *Section* 9.

4. A Leaſe of ſome Land is to be let for 14 Years, 'tis worth 1460 *l.* in ready Money; now ſuppoſe, he that takes it can pay but 450 *l.* ready Money, what Annual Rent muſt he pay to equal the remainder of the Money, *Compound Intereſt* being computed at 6 *l. per Cent. per Ann?* *Anſwer*, 108 *l.* 13 *s.* 2 *d.* ½ *near*, by *Section* 9.

5. A Leaſe of an Eſtate to be let for 7 Years, 'tis worth 206 *l.* Fine, and 36 *l. per Ann.* Now admit, he that takes it would lower the Rent to 10 *l. per Ann.* The Queſtion is how much the Fine muſt be Enhaunc'd, *Compound Intereſt* being computed at 10 *l. per Cent. per Ann.*

Find the difference of the Yearly Rents which is 26 *l. then the preſent worth of an Annuity of* 26 *l. to continue* 7 *Years at* 10 *l.* per Cent. (by *Section* 8.) *which is* 126 *l.* 11 *s.* 6 *d.* ¾

The

the Enhaunc'd Fine, this added to 206 *l. the former Fine makes* 332 *l.* 11 *s.* 6 *d.* $\frac{3}{4}$ *the whole Fine the Tennant ought to pay, to perform the Conditions required.*

6. What Annuity to continue 15 Years, will 1000 *l.* due 4 Years hence Purchase, allowing Compound Interest on both sides at 6 *l. per Cent. per Ann.*

Find by Section 6. *the present worth of* 1000 *l. due* 4 *Years hence, which is* 792 *l.* 1 *s.* 11 *d.* $\frac{1}{2}$ near, *then by* Section 9: *what Annuity to continue* 15 *Years,* 792 *l.* 1 *s.* 11 *d.* $\frac{1}{2}$ *will Purchase, which will be* 81 *l.* 11 *s.* 1 *d.* $\frac{1}{2}$ *near, the Answer.*

7. The Lease of a House is worth 30 *l. per Ann.* of which there is 4 Years yet to come, what present Money must I pay for a Ten-Year's Lease to commence at the Expiration of the old Lease, computing Compound Interest at 6 *l. per Cent. per Ann.*

Find the present worth of 1 *l. Annuity to continue* 14 *Years, which is* 9.29498, *and also the present worth of* 1 *l. Annuity to continue* 4 *Years, Which is* 3.46510. *The difference of these two present worths,* viz. 5.82988 *is the present worth of* 1 *l. for the Ten-Years in Reversion after the* 4 *Years; this Mutiply by* 30, *the propos'd Annuity gives* 174 *l.* 17 *s.* 11 *d.* $\frac{1}{4}$ *near, the* Answer.

Fellow-

Fellowſhip, Company or Society,

SO called, becauſe it teacheth to find out the ſeveral Shares of a Gain or Loſs, reſulting from a joint or common Stock, and that in ſuch Proportion as are the Shares. And therefore this Rule is of great Uſe amongſt Merchants, who Trade in Company with a Joint Stock.

Of Fellowſhip there are two Kinds, *viz.* Single and Double; *that is*, without, and with Time.

Single Fellowſhip, or Fellowſhip without Time, is when divers Perſons make a Joint Stock, and each Perſon concerned therein, receiveth a ſhare of the Gain, or beareth a ſhare in the Loſs proportional to his Stock, without conſidering the time 'tis in; *that is*, it ſuppoſeth all their Stocks to lye the ſame time in Bank.

The Rule for working Quſtions in Single Fellowſhip is this,

As the Sum of all their Stocks, to the total Gain or Loſs, ſo is each Man's particular part, to each Man's proper ſhare in the Gain or Loſs.

That is, *Add the ſeveral Shares of the Perſons together, the Sum is the firſt Term in the Rule of Three; the whole Gain or Loſs the ſecond, and each Perſons particular Share he puts into the Stock the third.*

Here

Here working according to the Rule of Three direct, there will come out a fourth Proportional, which is the Gain or Loss required.

And here Note, that the Operation must be so many Times repeated as there are Partners.

Exam. Three Persons make a Joint Stock, of which A put in 184 *l.* 10 *s.* B 96 *l.* 15 *s.* and C 76 *l.* 5 *s.* they Trade, and Gain 220 *l.* 12 *s.* what must each Person have of this Gain.

184: 10
96: 15
76: 5
357: 10

If 357 *l.* 10 *s.*—220 *l.* 12 *s.*——184 *l.* 10 *s.*

20	20	20
7150	4412	3690
	3690	
	39708	
	26472	
	13236	

7150)16280280(2276 $\frac{688}{715}$

1980

5502

4978 — 113 *l.* 16 *s.* $\frac{688}{715}$ A's Share

6880

Again,

Again, If 7150 s.————4412 s.——

96.15
20

1935
4412 — 4412

3870 — 3870
1935
7740
7740

7150)8537220(1194

1387
59.14 $\frac{12}{713}$ B's Share.
6722

2872

012

Thirdly,

Thirdly, If 7150 s.——————4412 s.

```
      76.5
      20
     ————
     1525
     4412
    —————
      3050
     1525
    6100
   6100
   ——————
7150)6728300(941
  ————o————
      2933    47.01 15/715 C's Share.
      ————
       730
       ———
        15
       ———
```

Note, This last Stating is needless, if you are sure the two first are work'd Right, for having got the Gain of A and B, add them together, and substract the Sum from the whole Gain, the remainder will be the Gain of C.

The

The Proof of this Rule is by Addition, for the Sum of the particular Gains, must make the whole Gain. As in the preceding Example,

	l.	s.	
A's share was	113	16	$\frac{688}{715}$
B's share was	59	14	$\frac{12}{715}$
C's share was	47	01	$\frac{15}{715}$
	220	12 the whole Gain	

More Examples.

Three Merchants Company, the first put in 120 *l.* 12 *s.* the second 98 *l.* 14 *s.* the third a certain Sum; they Gain 110 *l.* 10 *s.* of which the third Person is to have for his share 34 *l.* 16 *s.* what must the first and second have of the Gain? And what did the third put into Company? *Answer*, The first 41 *l.* 12 *s.* 07 *d.* $\frac{690}{4386}$. and the second 34 *l.* 01 *s.* 4 *d.* $\frac{3696}{4386}$. third put in 100 *l.* 16 *s.* 03 *d.* $\frac{542}{1514}$.

Three Persons A. B and C make a Joint Stock of 400 *l.* A put in 198 *l.* 14 *s.* they Gain 226 *l.* 10 *s.* of which Gain B is to have 30 *l.* more than C; I demand each Man's Share of the Gain, and what B and C put into Company? *Answer*, A's 112 *l.* 10 *s.*

10 *s.* 03 *d.* $\frac{2640}{8000}$. B's 71 *l.* 19 *s.* 10 *d.* $\frac{2680}{8000}$. C's 41 *l.* 19 *s.* 10 *d.* $\frac{2680}{8000}$. and B put in 127 *l.* 02 *s.* 09 *d.* $\frac{26784}{43488}$. and C put in 74 *l.* 03 *s.* 02 *d.* $\frac{16704}{43488}$.

Double Fellowship, *Or Fellowship with Time, is when several Persons make a Joint Stock, without an equality of Time; but each Partner puteth in his Money, or taketh it out of the Joint Stock as occasion requires.*

For working of Questions in this Rule, do thus, *Multiply each Man's Stock by the time it lay in Bank, and add all the Products together; the Sum shall be the first Term, the whole Gain or Loss the second, and each Person's Product of Stock and Time the third.*

Example 1. Three Persons make a Stock, the first put in 96 *l.* for 8 Months; the second 58 *l.* for 14 Months; the third 40 *l.* for 22 Months: They Gain 240 *l.* what is each Man's Share of the Gain?

l. Mult. by	Mon. gives	
96	8	768
58	14	812
40	22	880
		2460

As 2460 —— 240 —— 768

Answ. 74 *l.* 18 *s.* 6 *d.* $\frac{108}{246}$.

Again,

Again, as 2460———240———812
Answ. 79 *l.* 4 *s.* 4 *d.* $\frac{168}{246}$.

Thirdly, as 2460———240———880
Answ. 85 *l.* 17 *s.* 0 *d.* $\frac{216}{246}$.

These three Sums added together will give the whole Gain, if the Queſtion be wrought Right, and is therefore an infallable Proof of this Rule.

First Share 74 *l.* 18 *s.* 6 *d.* $\frac{108}{246}$.

Second Share 79 *l.* 4 *s.* 4 *d.* $\frac{168}{246}$.

Third Share 85 *l.* 17 *s.* 0 *d.* $\frac{216}{246}$.

Proof 240 *l.* 0 *s.* 0 *d.*

Example 2: A Garriſon hath 40 Troopers, and 60 Soldiers in it, the Yearly pay of it is 4000 *l.* But each Trooper has 6 times the pay of a Soldier, how much of this Yearly charge muſt be paid to the Troopers, and how much to the Soldiers.

In this Caſe you muſt Multiply the Number of Horſe by 6, and the Number of the Foot by 1, as followeth,

40 by 6 makes 240
60 by 1 makes 60

300

From

From this 'tis Evident, that the Horses Mony to the Foots is as 240 to 60. so that the 4000 *l.* must be divided into two such Parts, that the greater may be the lesser, as 240 to 60, to do which say,

As 300 to 4000, so is 240 to 3200*l.* the Horse-mens Money.
As 300 to 4000, so is 60 to 800 *l.* the Foots Money.

More Examples.

Three Merchants A. B. C. enter Partnership for a Year, A put in 100 *l.* but on the first of *April* following took out 20 *l.* B put in the first of *March* 60 *l.* and the first of *August* 100 *l.* more. C put in 140 *l.* the first of *July*, but the first of *October* takes out 40 *l.* At the Year's end there was gained 142 *l.* what must each Person have of this Gain? *Answ.* A 51 *l.* B 55 *l.* C 36 *l.*

In Cases of this Nature, Multiply the several Disbursements by the proper time of its continuance, and because within the limited time they took out, and put in again; therefore when you have Multiplied the Sum put in by the proper time it lay, add the Products together, so shall the Sum be the Product of Stock and Time.

For Instance, in the preceding Question, A put in 100 *l.* which continued in three

Months, which Multiplied made 300, and then taking out 20, there was left but 80, which continued in 9 Months, this Multiplied made 720, the Sum of these two is 1020; and this is all A's Stock into his Time. Do the like for B and C.

Note, If there be odd Days, all must be reduc'd to Days, and so Multiply by those Days, just as you did when the time was given in Months.

There is an Army consisting of 30000 Foot, and 6000 Horse; the Foot have 9 *d.* *per* Day, and the Horse Men 2 *s.* 6 *d.* *per* Day, they take a Booty worth 15000 *l.* which is to be divided betwixt them in such Proportion as are their Wages, What must each Party have of this Booty? *Answ.* The Foot must have 9000 *l.* and the Horse 6000 *l.*

Three Shepherds take a piece of Ground for 200 *l.* 10 *s.* In which A put 860 Sheep for 7 Months, B put in 750 Sheep for 6 Months, and C put in 500 Sheep for 4 Months; what must each Man pay of the 200 *l.* 10 *s*? *Answ.* A must pay 96 *l.* $\frac{509}{1252}$, B 72 *l.* $\frac{81}{1252}$, and C 32 *l.* $\frac{36}{1252}$.

ALI-

ALIGATION.

IS so called, because it Treateth of the Mixing or Incorporating of divers Simples into one Mass, showing how much you shall take of each Simple. It consists of two Parts, *viz.* *Medial* and *Alternate*.

Aligation Medial, Is when the Quantity and Rates of several Simples are given, and 'tis required to find a mean Price, that the whole Mixture, or any part thereof may be afforded at. For doing which, this is the *Rule*,

As the whole Quantity of the Simples,
To the whole Value of them;
So is any part of the Mixture,
To the mean Price required.

For *Exam.* There is mixed with 10 Bushels of Oats, at 24 *d.* the Bushel; 7 Bushels of Barley, at 30 *d.* the Bushel; 17 Bushels of Rye, at 40 *d.* the Bushel; and 22 Bushels of Wheat, at 48 *d.* the Bushel. The *Question* is, what one Bushel of this Mixture is worth?

Having added the several Quantities together, (which make 56 Bushels) find the Value of them by Multiplying each Number of Bushels by the Pence they cost, thus doing you will find that the Oats cost 240 *d.* the Barley 210 *d.* the Rye 680 *d.* and the Wheat 1056 *d.* which altogether make 2186 *d.* the Value of all the Simples; then to find what any quantity of this Mixture is worth, say,

As 56 Bush. (*the Sum of the Quantities*)
To 2186 *d.* (*the Value of the Simples*)
So is any Quantity, suppose 1 *Bush.*
To 39 *d.* (*the mean Price required.*)

Or, If the Price of but one Measure or Part be required; take this Rule,

Divide the Total of all the Prices which is 2186, *by the Total of all the Simples to be mixed* 56, *the Quote is* 39, *the Price required, near.*

Proceeding according to either of these Rules, you will find that one Bushel of this Mixture is worth 39 *d.* and $\frac{1}{28}$ of a Penny, which is $\frac{4}{28}$ or $\frac{1}{7}$ of a Farthing: See the following Operation,

As

B. d. B.
As 56———2186———1
1

56)2186(39 d. $\frac{2}{56}$ or $\frac{1}{28}$.
506
2

Notes 1. When the price of one is required, then the two preceding Rules become one and the same, becanse one does not Multiply; but, if the Price of 2, 3, 4, *&c.* Bushels be required, it must be done by the first Rule.

2. If you would have of the former Mixture any Quantity, suppose 200 Bushels, then you must work thus, *As 56 Bushels to 200, so is 10 the Number of Bushels of Oats, to the fourth Number, which is 35 $\frac{40}{56}$ Bushels, the quantity of Oats to be mixed.* Proceeding thus with the rest of the Simples you will find, that with the 35 $\frac{40}{56}$ Bushels of Oats, there must be mingled 25 Bushels of Barley, 60 $\frac{40}{56}$ of Rye, and 78 $\frac{32}{56}$ of Wheat; the Sum of which will make 200 Bushels, the Quantity required.

3. If you have Two, Three, Four, *&c.* several Things, and would mix equal Parts

of them together, add their Prices, and take $\frac{1}{2}$ of the Sum, if you mix two Simples together, for the Price of one part of ſuch Mixture; Take $\frac{1}{3}$ if you mix three together; and the $\frac{1}{4}$ if you mix four, *&c.* For *Example*, If 20 Ounces of Gold at 4 *l.* an Ounce, be melted with 20 Ounces of Silver at 5 *s.* an Ounce; what will an Ounce of this Mixture be worth, 80 *s.* the price of an Ounce of Gold, 5 *s.* the price of an Ounce of Silver, the Sum of which is 85 *s.* whoſe half is 42 *s.* 6 *d.* or 2 *l.* 2 *s.* 6 *d.* the price of one Ounce of this Mixture.

4. If the price of one Simple be given in Shillings, another in Shillings and Pence, and a third in Pence; they muſt all be reduced to the loweſt Denomination.

The *Proof* of this Rule is thus, *As that part of the Compoſition whoſe price you ſought, is to its price, ſo is the whole Compoſition, to the whole Price.* As in the preceding *Example*, where one Buſhel of the Mixture was worth 39 *d.* $\frac{1}{28}$, therefore, I ſay, if 1 Buſhel coſt 39 *d.* $\frac{1}{28}$, what ſhall 56 Buſhels coſt. Here working according to the Rule of Three direct, you will find the price of the 56 Buſhels to be worth 2186 *d.* which is, as it was given in the Queſtion, and therefore proves the work to be right.

More

More Examples.

A Goldsmith hath 756 Ounces of Fine Silver, worth 6 *s.* 2 *d.* the Ounce, to be mingled with 68 Ounces of Copper, worth three Farthings an Ounce; what is one Ounce of this Mixture worth? *Answer*, 5 *s.* 7 *d.* $\frac{3}{4}$ $\frac{676}{824}$

A Grocer hath 4 sorts of Sugar, *viz.* 50 *l.* at 1 *s.* 6 *d.* the pound, 70 *l.* at 1 *s.* 10 *d.* 112 *l.* at 2 *s.* 6 *d.* and 150 *l.* at 3 *s.* the pound; all these he would mix, and have of the Composition 1000 Pound weight; how much of each sort must he take? And what will the price of a Pound of this Mixture be worth? *Answer*, 130 *l.* $\frac{340}{382}$ at 1 *s.* 6 *d.* the Pound, 183 $\frac{94}{382}$ at 1 *s.* 10 *d*, 293 $\frac{74}{382}$ at 2 *s.* 6 *d.* 392 $\frac{256}{382}$ at 3 *s.* The price of the Mixture 2 *s.* 5 *d.* $\frac{61}{191}$.

Aligation Alternate, Teacheth when having the Values of divers Simples, what Quantities of each must be mixed, so that the whole Composition may bear a price propounded? Of this *Aligation* there are 3 Kinds,

First, When the price of each Simple is expressed, but no Quantity given, and 'tis required how to mix the Simples, to Sell a certain Quantity at a mean Rate.

For *Example*, Rye at 16 *s.* the Quarter, Barley at 18 *s.* the Quarter, Oats at 13 *s.* the Quarter, and Peaſe at 10 *s.* the Quarter; How much of each muſt I mingle together, ſo that the whole Maſs may be worth 14 *s.* the Quarter.

Secondly, When the Quantity of one Simple is given, as alſo the price of each Simple; and 'tis required, what Quantity of each of the other Simples may be mixed therewith, ſo as to Sell the ſaid Mixture at a mean Rate?

As if with 70 Gallons of Canary at 8 *s.* the Gallon, I would mix Sherry at 5 *s.* the Gallon, Old Hock at 4 *s.* the Gallon, White Wine at 2 *s.* the Gallon; and it be demanded how many Gallons of each of theſe muſt be mingled with the ſaid 70 Gallons of Canary, ſo that the whole Mixture may be ſold for 7 *s.* the Gallon? 7.

Thirdly, When the price of each Simple is given, but none of their Quanties expreſt; and 'tis required, what Quantity of each muſt be taken, to make up a certain Quantity to be ſold at a mean Rate?

As, ſuppoſe, I have Silver of 7, 8, and 12 Ounces fine, and I would have a Maſs of 150 Ounces, of 9 Ounces fine; how much of each ſort of Silver will make the ſaid Maſs.

Notes

Notes 1. That the ſeveral Quantities be of the ſame kind, that is, all Pounds, Ounces; Gallons, Quarts, *&c.*

2. That the price of the mixt Quantity be betwixt the given Prices.

3. That in Combining them together, a greater and leſſer than the mean is always to be joined.

4. That the Exceſs betwixt the mean and great Extream is ſet againſt the leſſer, and the Exceſs betwixt the mean and leſſer is ſet againſt the greater.

5. When there is more than one greater or leſſer Extream, they may be often linked together, and have different Exceſſes for one ſort, whence there will be ſeveral Anſwers, yet all True.

6. If either of the Extreams be ſingle, ſuch Extream muſt be linked with all the reſt, in which Caſe there will be but one Anſwer.

Theſe Things obſerved, the Direction for placing and working any of the preceding Varieties, is as followeth,

The order of Combining them is thus, Place the Prices of the ſeveral Simples, ſo that the greateſt Stand in the higheſt place, and the next inferior Price under the former, and ſo proceed with the reſt Succeſſively, placing the mean

Rate

Rate or Price on the Left-hand of the ſaid Rates or Prices.

Then in the firſt Caſe, Aligation Alternate, alone Anſwers the Queſtion; In the ſecond Caſe, Aligation, and the Rule of Three; In the third Caſe, Aligation, Addition of the Exceſſes, and the Rule of Three performes the Buſineſs.

The Firſt Kind.

Rye at 16 *s.* the Quarter, Barley at 18 *s.* Oats at 13 *s.* and Peaſe at 10 *s.* the Quarter; how much of each muſt be mingled, ſo that one Quarter of this Meſtling may be worth 14 *s.*

	s.	Q.	
14	18	4	Barley.
	16	1	Rye.
	13	2	Oates.
	10	4	Peaſe.

Whence you ſee that 4 Quarters of Barley, one of Rye, two of Oats, and 4 of Peaſe, at the Rates above mentioned, muſt be mingled together, to make a Maſs to be ſold at 14 *s.* the Quarter.

The

The Second Kind

With 70 Gallons of Canary at 8 *s.* the Gallon, I would mix Sherry at 5 *s.* the Gallon, Old Hock at 4 *s.* the Gallon, White Wine at 2 *s.* the Gallon; how much of each must be mingled with the 70 Gallons of Canary, so that the Mixture may be sold for 7 *s.* the Gallon. 7.s

Combine them together just as in the former, without considering that the Quantity of one Mixture is given.

	8	5.3.2	10 Canary.
	5	1.	1 Sherry.
7	4	1.	1 Hock.
	2	1.	1 W. Wine.

Here 'tis Evident, (was no Quantity of Canary assign'd) there ought to be 10 Gallons of Canary, and one Gallon of each of the other Wines; and therefore to find how much must be mingled with 70 Gallons of Canary. *Say,*

	Gal.	Gal.	Gal.
As	10 ———	70 ———	1

10)70(7 Gallons,

And, because all the Differences are alike, this one Proportion does the Business, (else

(else there must have been 3) and shows, that with 70 Gallons of Canary, there must be put 7 Gallons of Sherry, 7 of Hock, and 7 of White Wine, to make a Mixture worth 7 *s.* the Gallon,

The Third Kind.

There is Silver of 5, 8 and 12 Ounces Fine, and I would have a Mass of 150 Ounces, of 9 Ounces Fine; how much of each sort will make the said Mass.

Here also Combine them after the same manner as before.

$$9\left\{\begin{array}{c}12\\8\\5\end{array}\right.\quad\begin{array}{l}1.4\\3.\\3.\end{array}\left\{\begin{array}{l}5 \text{ of } 12 \text{ Ounces Fine.}\\3 \text{ of } 8 \text{ Ounces Fine.}\\3 \text{ of } 5 \text{ Ounces Fine.}\end{array}\right.$$

In this Case 'tis evident, that did my Mass consist but of 11 Ounces; then 5 Ounces of 12 Ounces Fine, and three of each of the other would Answer the Question; but since a Mass of 150 Ounces of that Fineness is required. Say therefore,

Oun. Oun. Oun.
As 11——150——5
5

11)750(68 Oun. $\frac{2}{11}$ of 12 Oun. fine.

90

2

Oun. Oun. Oun.
Again, as 11——150——3
3

11)450(40 Ou. $\frac{10}{11}$ of 8 Ou. fine.

10

And of 5 Ounces Fine, there will be the ſame Quantity as of 8 Ounces Fine; which three Quantities, *viz.* 68 $\frac{2}{11}$, 40 $\frac{10}{11}$, and 40 $\frac{10}{11}$, of 12, 8 and 5 Ounces Fine, will make up the Maſs of 150 Ounces of 9 Ounces Fine.

The *Proof* of this Rule, is by comparing the Total Value of the ſeveral Simples of which

which the whole Mixture is composed, with the worth of the whole Mixture so composed, and if the Sums agree, the work is right.

As in the second *Example*, The value of 70 Gallons of Canary at 8 *s.* the Gallon, is 560 *s.* the value of 7 Gallons of Sherry at 5 *s.* the Gallon, is 35 *s.* the value of 7 Gallons of Old Hock at 4 *s.* the Gallon, is 28 *s.* and the value of 7 Gallons of White Wine at 2 *s.* the Gallon, is 14 *s.* These 4 Sums of Money added together make 637 *s.*

This done, add the Gallons together, *viz.* 70. 7. 7 and 7 they make 91. Now the Total value of 91 Gallons at 7 *s.* which is the mean price of one Gallon, will amount to 637 *s.* also, whence I conclude the work is right.

More Examples.

A Grocer hath 4 sorts of Sugars, *viz.* of 1 *s.* 6 *d.* the pound, of 1 *s.* 2 *d.* the pound, of 11 *d.* the pound, and 3 *d.* the pound; what Quantity of each of these must be mixt, so that one pound of such Mixture may be worth 3 *d.* $\frac{1}{2}$. *Answer*, 1 *l.* at 1 *s.* 6 *d.* 1 *l.* at 1 *s.* 2 *d.* 1 *l.* at 11 *d.* and 65 *l.* at 3 *d.*

A Woolmonger hath divers sorts of Wool, one of 11 *d.* the pound, another of 9 *d.* the pound, another of 8 *d.* the pound; how many pound of each of these Prices

must

must he mingle with some of 3 *d.* a pound to make the Quantity of 5000 pound weight of 6 *d. per* pound? *Answer*, There must be of that 11 *d.* 9 *d.* and 8 *d.* 789 $\frac{2}{19}$ of each, and 2631 $\frac{11}{19}$ *l.* of 3 *d.* the *l.*

The Rule of False, or Position.

THIS Rule is so called, because we put a False or Suppositious Number, to find out the true one demanded.

Of Position there are two Kinds, *viz. Single* and *Double.*

The manner of operating in single Position is thus, *Suppose a Number at venture; and with that supposed Number work in all respects, as if were really the true one, till at last a result comes out, which result if it be true, Answers the Question, If not, it must be regulated by the single Rule of Three direct.*

Thus, as the Total arising from the Error, to the true Total, so is the supposed Part, to the true Part.

For *Example*, A Person dying, left 504 *l.* to be distributed among 3 Persons, *viz.* A, B, C in this manner, A was to have a certain

certain Sum, B twice as much as A, and C thrice as much as A, what was each Man's Share.

		$l.$
Suppose A to have		50
Then B must have		100
And C		150
	Total	300

Then as 300 is to 504, so is 50 $l.$

$$\begin{array}{r} 50 \\ \hline 300)25200(\ 84\ \text{A's share.} \\ 168\ \text{B's share.} \\ 252\ \text{C's share.} \\ \hline 504 \end{array}$$

The Operation of this is very plain, for having Muitiply'd the second Term by the third, and divided the Product by the first, there comes out 84 which is A's true share, this doubled gives 168 B's true share, and 84 tripled gives 252 C's true share, and the Sum of all is 504 $l.$

More Examples.

A Person bought 45 Yards of Black, and 60 Yards of Red Cloth, which cost him together

together 24*l.* 15*s.* But every Yard of Red Cloth, was double the price of a Yard of Black; what was the price of a Yard of Black Cloth? *Answer*, 3 *s.*

One Being ask'd the Money he had in his Pocket, answered, that if the 3d, 4th, 5th of it were added together, it would make 188 *l.* what was the Money he had? *Answer*, 240 *l.*

Suppose a Cestern with 3 unequal Cocks, containing 60 Tun, if the great Cock be set open, the Water will void clean in one Hour; at the second 'twill require two Hours; and at the third in three Hours: In what space of Time will it void, if all the Cocks are set open? *Answ.* 32 Minuts $\frac{8}{11}$.

And here Note, Both in this, and that of Double Position. That you take care to chuse such a Number for the Position, as hath the Parts exprest in the Question without a Remainder, and then you'l avoid Fractions.

Double Position, Is when we take two False Positions to arrive at the Truth. *As thus,*

Having supposed a Number, and with it proceeded to the Solution of the Question, by trying whether it will Answer all the Properties thereof, which, if it doth not,

then is my Suppoſition too much or too little, which by comparing it with the Truth, I find the Difference, and as it is too much or too little, Note it as my firſt Error.

This done, I again make a new Suppoſition, and working with this, as with the former, (if not the Truth) a ſecond Error ariſes, which by comparing it with the Truth ſhows me whether 'tis too much or too little; and accordingly I note it for my ſecond Error.

Theſe two Errors I Multiply by their contrary Poſitions; that is, the firſt Poſition by the ſecond Error, and the ſecond Poſition by the firſt Error, then if the Errors are a like; that is, both too much, or both too little, I ſubſtract the leſs Product from the greater, and the Remainder is the Dividend; but if the Errors were different, that is, one too much, and the other too little, I add thoſe Products together, and keep the Sum for a Dividend, which muſt be divided by the difference, or Sum of the Errors, according as they are like or unlike, the Quotient will give the Number ſought for, Which will Anſwer all the Conditions of the Queſtion.

For *Example*, A Goldſmith hath two Silver Cups, with a common Cover weighing 8 Ounces, if the Cover be put on the firſt or leſſer Cup, it will be $\frac{3}{4}$ the weight of the greater, but if it be put on the ſecond or greater,

greater it will be 4 times the weight of the lesser, what's the weight of each Cup.

10 first Posit. first Cup.
8 weight Cover.
—
18 weight first Cup and Cover.
—
Then 24 weight second Cup.
8 weight Cover.
—
32 weight second Cup and Cover.
40 four times first Cup.
—
8 first Error too little.
—

Again 20 second Posit.
8

28 weight first Cup and Cover.

Then $37\frac{1}{3}$ weight second Cup.
8

$45\frac{1}{3}$ weight 2d Cup and Cover.
80 four times weight first Cup.

$34\frac{2}{3}$ second Error to little.

20 second Posit.
8 first Error.

160

$34\frac{2}{3}$ second Error.
10 first Posit.

$346\frac{2}{3}$ first Product.
160 second Product.

$186\frac{2}{3}$ diff. Products.

$34\frac{2}{3}$ second Error.
8 first Error.

$26\frac{2}{3}$ diff. Errors.

$\frac{\ }{3})\frac{560}{3}(\frac{1680}{240} = 7$ the weight of the first Cup.

More

More Examples.

A certain Person left 1277 Crowns to be disposed after this manner, the first was to have a certain Sum, the second twice so much wanting 54 Crowns, the third three times so much wanting 81; how many must each of them have? *Answ. First* 235 $\frac{1}{3}$. *second* 416 $\frac{2}{3}$. *and the third* 625.

There is an Army to which if you add $\frac{1}{2}$, $\frac{2}{3}$ and $\frac{3}{4}$ of it, taking from the Sum 5000, there will Remain 100000; what was the Number of the Army? *Answ.* 36000.

One buys 2 Horses with a Burthen worth 100 Crowns, if this Burthen be put on the first Horse, it will make him of equal price with the second; but if the Burthen be put upon the other Horse, he will be double the price of the first, the Question is the price of each Horse? *Answer, First* 200 *Crowns, Second* 300.

The Extraction of the Square and Cube Root, both in whole Numbers and Fractions.

IF any Number be propoſed, then is that Number called the *Root*, or *firſt Power*, and if ſuch Number be Multiplied by it ſelf, the Product is called the *Square*, or *ſecond Power*; and if this ſecond Power be Multiplied by the Root, or firſt Power, 'tis called the *Cube*, or *third Power*; and if this Cube, or third Power, be Multiplied by the Root, or firſt Power, the Product is called the *Biquadrate*, or *fourth Power*, *and ſo on.*

Let 4 be propoſed for the Root, or firſt Power, than 16 is the Square, or ſecond Power; and 64 the Cube, or third Power; and 256 the Biquadrate, or fourth Power, *&c.*

When therefore a Number is given, and its Square, or Cube Root requir'd, the Operation is called the *Extraction of the Square*, or *Cube Root.* Which Operation is

is no more than the way or manner of finding ſuch Root from a given Number.

Sect. 1. In order to the extracting the ſquare Root of any Number, the following Table will be neceſſary, which ſhows you the Squares of the 9 Digits.

Root	1	2	3	4	5	6	7	8	9
Square	1	4	9	16	25	36	49	64	81

If a Number under 100 be given, and its Square Root requir'd, then if it be not expreſſed in this Table; take the Square Root of the Number that is the next leſs, thus the Square Root of 72 is 8, for 64 is the next leſs Square.

The method of operating in the ſquare Root is thus, when a number is given, and the ſquare Root of it requir'd, you muſt firſt prepare it for Extraction, by puting a point over every other Figure, beginning at the firſt Figure next the Right-hand, and ſo proceeding to the Left; *that is*, you muſt put a point over the 1ſt, 3d, 5th, 7th, 9th, *&c.* as the Number 576 is thus prepared $\dot{5}7\dot{6}$ and ſo of any other. Which preparation ſhows you the Number of Places the Root will contain.

The Number being thus prepared, and a crooked line drawn on the Right-hand, as is usually done in Division, *Proceed thus*, seek the square Root of the first square 5, this by the preceeding Table I find to be 2, which Figure 2 I set down in the Quotient, and the square of it under the first square of the given Number which is 5, this I substract there from, seting the remainder underneath, as you may see in the Margent.

576(2
4
——
1

This done, I bring down to the remainder (1), the next square or period of the given Number, (*viz.* 76.) and set it on the Right-hand thereof, it makes the Number (176) which Number is called the *Resolvend.*

576(2
4
——
4)176

Double the Root (2) placed in the Quotient, and set the said double (which is 4) on the Left-hand of the *Resolvend* like a Divisor, which will make the work stand as you see in the Margent.

Having done thus, Let the whole *Resolvend*, except the place of Unites, (which is that next the Right-hand, be esteemed a Dividend) then seek how often the Divisor (4) before found, is contained in the Dividend (17)? The *Answer*, (4) place in the Quotient, and also on the Right-hand

of

(4)

of the Divisor; *that is*, between the Divisor, and the crooked Line; as may be seen in the adjoining Operation.

```
 . .
 576(24
 4
 ---
44)176
```

Then Multiply all the Number (that is 44) standing on the Left-hand of the Resolvend by the Figure (4) last placed in the Quotient, and set the Product (176) orderly underneath the *Resolvend*; that is, Unites under Unites, and Tens under Tens, &c. Then having drawn a Line under the Product, substract the said Product (176) from the Resolvend (176) placing the remainder (if any) under its proper Figure, as is common in the Case of Substraction, and so is your work finished, because there is no more Figures to bring down, the Figures (24) in the Quotient being the exact square Root of 576, because there is no remainder.

```
 . .
 576(24
 4
 ---
44)176
   176
   ---
   ...
   ---
```

Notes 1. The Product before mentioned, must never be more than the Resolvend; for if it be so the Operation is false.

2. That

2. That for every particular Square distinguished by the Points, except the first of them, there will be a particular Resolvend, which is made by bringing down the following Square to the last Remainder; and so oft as there is a new Resolvend, so oft must there be a new Divisor, which Divisor is found by doubling or multiplying by 2 all the Root in the Quotient, let the Number of Places therein be never so many.

3. The Operation for finding a new Resolvend and Divisor must be repeated, for every Figure placed in the Root except the first.

I shall conclude this *Section* with the following *Example*.

Exam. 2. What's the square Root of 746342.

Having pointed the Number as before directed, I seek the square Root of 74 which I find to be 8, this (8) I set in the Quotient; and the square of it (64) under 74. and substract therefrom setting the Remainder (10) exactly underneath its respective Figure. To this Remainder (10) I bring down the next Square, (*viz.* 63) which I set on the Right-side (of 10) it makes (1063) the first Resolvend.

This

```
 . . .
746342(8 root
64
———
1063
```

This done, I double (8) the Root, and place its double (16) in a crooked Line before the Resolvend for the Divisor, then I seek how often the Divisor (16) is contained in the Dividend (106) which I find to be 6 times, this (6) I place in the Quotient, and also between the Divisor and crooked Line as before, which being done, I Multiply (166) the Number on the Left-hand of the *Resolvend*, by (6) the Figure last placed in the Quotient. The Product (996) I place under, and substract from the *Resolvend* (1063.) And to the Remainder (67) I bring down the next Square (42) *As appears in the Margent.*

```
      . . .
     746342(863
     64
     ———
 166)1063
      996
     ———
1723) 6742
      5169
      ———
      1573
```

Then proceeding, as before, I double the Root (86) for a new Divisor, setting the double (172) in a crooked Line before the Resolvend, the Divisor being thus gotten, I seek how often it is contained in (674) the Dividend, which is all the *Resolvend*, except the last Figure next the Right-hand. I find 3 times, which (3) I place in the Quotient, and also be-

betwixt the Divisor, and crooked Line; this done, I Multiply (1723) the Number on the Left-hand of the *Resolvend*, by (3) the Figure last placed in the Quotient. The Product (5169) I place under, and substract from the Resolvend (6742) the Remainder is (1573) which finishes the work.

From this Operation it appears, that the square Root of 746342 is more than 863, and yet less than 864. But how much more it is, is impossible to discover from any Rules of Art yet known, tho' some have affirm'd the Contrary.

But although we cannot know the exact Quantity, yet we may proceed infinitely near, which will serve in Practice, as well as if we could absolutely come to the Truth. As I shall show in the following *Section*.

Sect. 2. *To extract the square Root of a Decimal Fraction.* In order to this, *See that the Decimal consist of an even Number of Places, which if it doth not must be made so to do, by annexing a Cypher to the Right-hand of those that want*; and then Point and Operate as before directed.

Exam. What's the square Root of .57962

Here because the Decimal consists of an odd Number of Places, I place a Cypher on the Right-hand thereof, and then it will

stand

ſtand thus .579620, after which Operate juſt as you did in whole Numbers.

```
      .  .  .
      579620(.761 the ſquare Root.
      49
     ----
  146)896
      876
     ----
 1521)2020
      1521
     -----
       499
     -----
```

So that .761 is the ſquare Root of .579620 which was required.

But becauſe there is a Remainder .761, is not exactly the ſquare Root .579620 (nor perhaps the exact ſquare Root can never be obtain'd) but as I hinted before, you may come infinitely near, which thing is done by adding of Cyphers, for ſo many pairs of Cyphers as you add, ſo many more Decimal Places will there be in the Root; and therefore, the more Cyphers you add, the nearer you will come to the Truth.

I ſhall to the Remainder of the laſt *Example* add two pair or four Cyphers, and then proſecute the Operation.

```
15223)499.00.00(32
      45669
      -----
152262)423100
       304524
       ------
       118576
       ------
```

The two Figures placed to the foregoing Root gives .76132, which is considerably nearer than the former.

And if you will get the Root yet nearer, you may do it by adding more Cyphers, and carry on the Work.

After the same manner may you obtain the Root of any whole Number (that happens to be *Surd*) infinitely near by adding of Cyphers, and Prosecuting the Work as in the preceding Instance.

But that nothing may be difficult, I shall reassume the second *Example*, of whole Numbers in *Section* 1. where there remained 1573. In which *Example* the Quote or Root was 863, and to the Remainder shall add 3 pair or six Cyphers, and so carry on the work.

```
17269)157300:00.00(863.918
      155421
      ------
172781)187900
       172781
       ------
1727820)1511900
```

By which method I have got the Root to less than $\frac{1}{1000}$ part of Unity, whereas before, I had got it to but a little less than Unity. For every pair of Cyphers you add, so many Figures must you cut off in the Quotient, as Decimal Parts or Places.

If the square Root of a mixt Number be required, *See that the Decimal Part of it consist of an even Number of Places*, which if it doth not, *must be made so to do, by adding a Cypher to the Right-hand thereof; this done, let it be pointed as before directed*, and *then work as if it were a whole Number*. See the following *Example*.

What's the square Root of 25.632?

In this case I add a Cypher, because the Decimal consists of an odd Number of Places.

```
25.6320(5.06
25
-----
1006)06320
      6036
     -----
       284
```

Note 1. Becauſe there is two points over the Decimal, therefore there muſt be two Places prick'd off in the Right-hand for Decimal Places.

2. That the Operation may be carried on farther by adding of more Cyphers; as in the preceding Examples has been directed.

Sect. 3. If you would Extract the ſquare Root of a vulgar Fraction, Extract the ſquare Root of the Numerator, and ſet for a Numerator, and alſo of the Denominator, and ſet for a Denominator; the Fraction thus compoſed, is the ſquare Root of the former.

For *Example*, What's the ſquare Root of $\frac{4}{9}$. *Anſw.* $\frac{2}{3}$.

But Note, If either Numerator or Denominator, or both be *Surd*; that is, ſuch Numbers that the ſquare Roots of them can-

cannot be extracted. There is no other way but to reduce it to a Decimal, and then Extract the square Root of it.

So also, if the square Root of a *mixt Quantity* be required, 'tis best done by reducing it to a *Decimal mixt Quantity*; and then Extract the square Root of it as before has been directed.

The Proof of the Extraction of the square Root is Evident from the Definition of its operation. For since the Extraction of the square Root is to find such a Number, which if Multiplied by it self shall give the Number out of which the Extraction was made; if therefore you Multiply the Root or Quotient by it self, taking in the Remainder (if any) 'twill give you the Number you Extracted.

More Examples.

What's the square Roots of the following Quantities.

2304 ———	*Answ.* 48.
56169 ———	*Answ.* 237.
700569 ———	*Answ.* 837.
802816 ———	*Answ.* 896.
24681024 ———	*Answ.* 4968.
35022724 ———	*Answ.* 5918.
10536516 ———	*Answ.* 3246.
7645.7536 ———	*Answ.* 87.44

69426879.546— *Answ.* 8332.27 *near.*
8496.794526738 *Answ.* 92.17805 *near.*
9112367 98.7943651 *Ans.* 30186.699 *near.*
$\frac{4489}{5184}$ ———— *Answ.* $\frac{67}{72}$.
$\frac{447561}{952576}$ ———— *Answ.* $\frac{669}{976}$.

Sect. 4. The Extraction of the Cube Root is the Operation, by which from some given Number we find another Number, which being Multiplied by it self, and the Product again by the said Number, it shall produce the Number first given; and therefore any Number that is given, is conceived to be a Cube Number, which Cube Number may be either *Single* or *Compound.*

Single, When the Cube Root of it is le[ss] lefs — than 10, such are all Cubes under 1000.

Compound, When the Cube Root of the Number given is more than 9, such are all whole Numbers above 999.

The Roots of all Single Cubes, are exprest in the following Table.

1	2	3	4	5	6	7	8	9
1	8	27	64	125	216	343	512	729

2	3	4	5
2	3	4	5
4	9	16	25
2	3	4	5
8	27	64	125

And

And therefore when a Cube Number is given, that is under 1000, and yet not to be found in the Table, you must take the Root of the Cube that is next less. For *Example*, let 463 be given, the Root of the Cube that is next less is 7.

In this of the Cube, as well as in the Square, there is a Preparation to be made before the Extraction; *which is done thus*, put a point over the first Place next the Right-hand, and then another point over the fourth Place, another over the seventh, and another over the tenth, and so on; missing two Places betwixt every point, puting as many points as the Number will admit, these points show how many Places the Root will consist off.

By this Preparation the Number is distributed into several Cubes.

For *Example*, What's the Cube Root of 80621568.

First, The Number being prepared according to the preceding Direction it appears that the Cube Root of it will consist of three Places, and that the first Cube of it is 80, the second 621, the third 568, this being noted (having drawn a crooked line for the Quotient) seek the Cube Root of the first Cube (which is 4) and place in the Quotient, then subscribe the Cube of this

Root (which is 64) under (80) the first Cube, so that Units may stand under Units, and Tens under Tens, this done, having drawn a Line underneath, substract this Cube of the Quotient (64) from the first Cube, and set the Remainder (16) under its proper Figures.

. . .	2. To this Remainder bring
8062 1568(4	down the next Cube (621)
64	and place it on the Right-hand
———	thereof, and it will make
16621	(16621) the Number called

the *Resolvend*. *See the work in the Margent.*

3. This done draw a Line under the Resolvend, and triple the square of the Root (4), setting the said triple Square (48) under the *Resolvend*, so that Units in the said triple Square may stand under the place of Hundreds in the *Resolvend*.

4. Subscribe also the triple Root (*viz.* 12) so that Units in this may stand under the place of Tens in the *Resolvend*.

5. The triple Square of the Root, and triple Root being placed as before directed, draw a Line under, and add them together, in the order they are placed, the Sum (492) is a Divisor.

6. The

6. The *Resolvend* (except the place of Units) (*viz.*) (1662) is the Dividend, then seek how oft the Divisor (492) is contained in the said Dividend. I find according to the Rules of Division 3 times, which I set in the Quote to the former Root.

7. This done, I draw a Line under the Divisor, and Multiply the triple Square (48) before subscribed by 3 the Figure last placed in the Root, and set the Product (144) under the triple Square, so that Units may stand under Units, and Tens under Tens.

8. Next I square the Figure (3) last placed in the Quotient, and Multiply the square (9) by the triple Root (12) before subscribed, placing the Product (108) so that Units in this may stand under Units in the triple Number.

9. I subscribe the Cube (27) of the Figure last placed in the Quotient, so that Tens in this may stand under Units in that the former Product.

80621568(43
64
16621 *Resolvend.*
48
12
492 *Divisor.*
144
108
27
15507
1114568 *Resolvend.*

10. Next draw a Line, and add the 3 Numbers last placed together, in the same order they are placed the Sum (15507) substract from the Resolvend, and place the Remainder (1114) in order underneath, as in common Substraction.

11. To this Remainder (1114) bring down the third Cube (568) and place it on the Right-hand thereof as before, it will make (1114568) a second *Resolvend.*

12. This done, begin again, and repeat the work of the 3d, 4th, 5th, 6th, 7th, 8th, 9th and 10th Rules just before mentioned; *that is,* draw a Line under this second *Resolvend,* and triple the square of the Root (43) it makes 5547, which set under this second *Resolvend,* so that Units in the triple Square may stand under Hundreds in the *Resolvend* as before, subscribe also the triple Root which is 129, so that Units in this may

may stand under Tens in the *Resolvend*; these two added together gives 55599 a Divisor, and all the *Resolvend* (*viz.* 111456) except the place of Units is the Dividend.

13. Then seek how often the Divisor (55599) is contained in the Dividend (111456)? The Answer is 2 according to Division, which 2 I set in the Quote to the former Root; then drawing a Line under the Divisor, Multiply the triple Square (5547) by (2) the Figure last placed in the Quotient, it makes (11094) placing Units of this under Hundreds in the Resolvend, and the triple Root (129) by (4) the square of the Figure last put in the Quotient, the Product (516) put under the former, so

80621568(432 Root.
64
16621 *Resolvend.*
48
12
492 *Divisor.*
144
108
27
15507
1114568 *Resolvend.*
5547
129
55599 Divisor.
11094
516
8
1114568

ſo that Units in this may ſtand under Tens in that.

Laſtly, I ſubſcribe (8) the Cube of the Figure laſt ſet in the Quotient, ſo that Tens of this Cube may ſtand under Units in the laſt Product; the Sum of theſe three Products (1114568) I ſubſtract from the Reſolvend (1114568) and there Remains nothing, which ſhows that 432 is the exact Cube Root of 80621568.

Note. If the Sum of the laſt three Numbers be greater than the *Reſolvend*, the work is falſe, and muſt be rectified, by puting a leſſer Figure in the Quotient.

Sect. 5. The Cube Root of a Decimal Fraction is obtain'd, after the ſame manner as that of a whole Number, only you muſt make the Decimal to conſiſt of ſome Number of *Ternaries* or *Three's*; *that is*, the Decimal muſt conſiſt of *Three*, *Six*, *Nine*, *Twelve*, *&c.* places, which if it doth not, muſt be made ſo to do by adding of Cyphers.

So alſo, if it be a mixt Number, the decimal Part of it muſt be made to conſiſt of ſome Number of *Ternaries* of Places.

In like manner, if a whole Number happen to be *Surd*; *that is*, ſuch where there is a Remainder, then may the work be

be carried on farther, by adding some Number of *Ternaries* of *Cyphers*, and prosecuting the Operation.

Lastly, The Cube Root of a vulgar Fraction is goten by extracting the Cube Root of the Numerator, for a Numerator, and the Cube Root of the Denominator, for a Denominator. The former set over the later will make a Fraction, which shall be the Cube Root of the Fraction given.

The *Proof* of the Extraction of the Cube Root, is also Evident from the *Definition* of its *Operation*, which is to find a Number, that if Multiplied by it self, and the Product again by the said Number, it shall make the Number first given.

Multiply therefore the Root found in the Quotient by it self, and that Product again by it self (taking in the Remainder, if any) then if the second Product make the same Number as that is out of which the Extraction was made, the work is right, else not.

More

More Examples.

What's the Cube Roots of the following Quantities.

157464 ——— *Answ.* 54.
164566592 ——— *Answ.* 548.
32036235776 ——— *Answ.* 3176.
208253691022824 *Answ.* 59724.

Of Barter, Exchange, and Loss and Gain.

Sect. 1. BARTER, Is a Rule of great Use among Merchants, for it informs them in the Exchanging of one Commodity for another, and so to Proportion the Rates and Quantities, as that neither shall sustain Loss.

The Rule of Three is the only Rule used in solving Questions of this Nature.

Example 1. Two Merchants *Barter*, one hath 24 $\frac{1}{2}$ C. of Ginger, at 3 *l.* 14 *s.* *per* C. The other has Cotton at 13 *d.* $\frac{1}{4}$ *per* pound: How

How much Cotton must I give for the Ginger.

Say, If 1 C. cost 3 *l.* 14 *s.* what cost 24 $\frac{1}{2}$ C. *Answer*, 90 *l.* 13 *s.*

Then, If 13 *d.* $\frac{1}{4}$ buys 1 *l.* what shall 90 *l.* 13 *s.* *Answ.* 391 *l.* 12 *s.* 5 *d.* $\frac{1}{4}$ $\frac{35}{53}$, and so much Cotton must be given for the Ginger.

2. Two Merchants *Barter*, one has Mace at 27 *l.* 16 *s.* 4 *d.* *per* C. weight ready Money; but in *Barter* he will have 30 *l.* 10 *s.* *per* C. weight; the other has Cinnamon worth 23 *l.* 14 *s.* *per* C. weight ready Money. How must the latter sell his Cinnamon *per* C. weight, to make his *Barter* equal to the first.

Say, If 27 *l.* 16 *s.* 4 *d.* give 30 *l.* 10 *s.* what shall 23 *l.* 14 *s.* give? *Answ.* 25 *l.* 19 *s.* $\frac{4816}{6676}$ the price of one C. weight of Cinnamon in *Barter*.

3. A Merchant hath one hundred pieces of Velvet, worth 3 *l.* *per* Piece ready Money; these he *Barters* with another Merchant at 4 *l.* *per* Peice for *Spanish* Wool, at 7 *l.* 10 *s.* *per* C. weight, which is worth but 6 *l.* *per* C. ready Money; the Question is what Quantity of Wool pays for the Velvet, and which of the two Merchants is the gainer, and how much?

Say,

Say, If 7 *l.* 10 *s.* give 1 C. what shall 400 *l.* *Answ.* 53 C. $\frac{1}{3}$.

Then { If 1 C. give 6 *l.* what shall 53 C. $\frac{1}{3}$? *Answ.* 320 *l.*
And if 7 *l.* 10 *s.* give 6 *l.* what shall 400 l. *Answ.* 300 *l.* }

Whence it is manifest, that the true worth of the Wool was 320 *l.* and the true worth of the Velvet but 300 *l.* and therefore the Merchant that sold the Wool loseth 20 *l.* by the Bargain.

4. A Factor receives of his Merchant 1000 *l.* on Condition that he shall add to it 280 *l.* of his own Money, as also his trouble in Managing the whole Stock. For all of which he shall have $\frac{1}{3}$ of the whole, the Question is what the Factor's Service was valued at.

Say, If $\frac{2}{3}$ give $\frac{1}{3}$, what shall 1000 *l.* *Answ.* 500 *l.*

Now deducting 280 from 500, there will Remain 220, the value of the Factor's Service.

5. A Merchant Remits to his Factor, the Sum of 640 *l.* with allowing the Factor to put in 128 *l.* of his own, and by agreement the Factor's Service is estimated at a certain Value, which is such, that if the whole Gain be divided proportionably, according to those three Stocks, the Factor

so

for his Service will receive $\frac{1}{3}$ of the whole Gain; the Question is to know the whole Gain of each, and what the Factor's Service was valued at.

Add the Merchant's and Factor's Money together, the Sum is 768 *l.*

Then *say*, as $\frac{3}{3}$ to $\frac{1}{3}$ so is 768 *l.* to 192 *l.* and so much was the value of the Factor's Service.

This done, *say*, as the Sum of the three Stocks

$$960 \text{ to } 1, \text{ so is } \begin{cases} 640 \text{ to } \frac{2}{3}. \\ 320 \text{ to } \frac{1}{3}. \end{cases}$$

So that the Merchant had $\frac{2}{3}$ of the whole Gain, and the Factor $\frac{1}{3}$.

Sect. 2. **Exchange**, Properly signifies no more than to give one thing for another, and is therefore the same with *Barter*. But in Merchandizing 'tis commonly understood the giving of Coin for Coin; that is, the giving a Sum of Money in one place, to receive the same value in the Coin of another place: In order to which, there must always be a Comparison made between the Coins of our own, and the Coins of other Countries, and then the Question is easily answered by the Rule of Three Direct.

Exam. 1. If a *Frankfort Florin* be worth 4*s.* 9 *d.* Sterling; how many such *Florins* must I receive for 275 *l.* 10 *s.*

 Say,

Say, If 4 *s.* 9 *d.* give 1 *Florin*, what shall 275 *l.* 10 *s.* give? *Answ.* 1160.

How many Pounds Sterling must I pay in *England* for 17684 $\frac{1}{2}$ Gelders each 20 *d.* *Sterling*, receiv'd in *Holland*.

Say, If 1 Gelder be 20 *d.* what shall 17684 $\frac{1}{2}$ Gelders be? *Answ.* 1473 *l.* 14 *s.* 2 *d.*

2. If I pay in *London* 375 *l.* Sterling to receive at *Antwerp*, 21 *s.* 9 *d.* *Flemish* for every Pound Sterling; how many Pounds *Flemish* shall I receive at *Antwerp* for the said 375 *l.* Sterling?

Say, If 20 *s.* give 21 *s.* 9 *d.* what shall 375 *l.* give? The *Answer*, is 407 *l.* 16 *s.* 3 *d.* *Flemish*.

3. If 40 *d.* *English* be 2 Gelders *Dutch*, and 18 Gelders *Dutch* 5 *French* Crowns, and 15 *French* Crowns 4 *l.* $\frac{1}{2}$ Sterling; how many Pence *English* is 12 *l.* Sterling.

In such Questions as these, where there is a Comparison made between divers sorts of Coins, as when the First is compared to a Second, a Second to a Third, and that to a Fourth, there are two Varieties. 1. How many pieces of the first Coin are equal to a given Number of pieces of Coin of the last sort. Or 2. How many of the last pieces are equal to a given Number of the first.

For

For the doing of both which Cases take this Rule. *Set every other Number according to their Succession in the Question, in two Columns,* viz. *The First, Third, Fifth and Seventh,* &c. *(if there be so many) in the first Column, likewise the Second, Fourth, Sixth* and *Eight,* &c. *in the second Column.* As the Numbers in the former Example are thus placed.

Pence 40 = 2 *Dutch* Gelder.
Gelders 18 = 5 *French* Crowns.
French Crowns 15 = 4 ½ Pounds
Sterling, Pounds 12.

But in Case in the aforesaid Question, my demand had been [how many Pounds Sterling are equal to 720 *d.*] *Then I must have placed the 720 in the other Column; that is, under the 4 ½ pounds Sterling; for two Numbers of one Denomination must not be set in one Column, and therefore the last Number must always stand in the contrary Column to the Number of the same Denomination; this done, Multiply continually all the Terms in the Column where are most for the Devidend, do the like by all the Terms in the Column, where are least for the Divisor, divide the Dividend by the Divisor, the Quote is the Answer.*

See

See the Operation of the preceding Example.

=40	2		
=18	5		
=15	4 $\frac{1}{2}$		
12		45)129600(2880 *pence.*	
129600 :	45	396	
		360	

So that 2880 Pence *English* is 12 *l.* Sterling.

I have stated the Question in these common pieces of Coin, that the Reason and Truth of the Operation might the more plainer appear.

4. If 20 *Roman* Ducats be equal to 17 Crowns *Genoa*, and 40 Crowns *Genoa* be equal 54 Ducats of *Milan*, and 25 Ducats *Milan* equal 38 *Frankfort* Florins; how many *Frankfort* Florins is 120 *Roman* Ducats?
Answ. 209 $\frac{608}{2000}$ *Franckfort* Florins.

The same Rule will hold in Weights and Measures, where there is a Comparison made betwixt them.

Sect.

Sect. 3. Loss and Gain, Is a Rule that teacheth how, when Goods are bought at one Rate, to Retail them out ſo as to gain or loſe a certain Sum by the Sale thereof. For doing of which this is the Rule,

As the whole Quantity of Goods bought.
To the Total of the Sum given for the Goods and what you would Gain, or muſt Loſe thereby,
So is any part of the Commodity
To a fourth Number, for which if you Sell the ſaid part,
You will Gain or Loſe the Sum mentioned by the Sale of the whole.

Exam. 1. A Merchant bought 2196 Ells of Holland, which coſt 1156 *l.* 10 *s.* he propoſes to Gain by the Sale of the whole 98 *l.* how much muſt he ſell it for an Ell.

Say, as 2196 is to 1254 *l.* 10 *s.* ſo is 1 Ell to 11 *s.* 5 *d.* $\frac{228}{2196}$ the *Anſw.*

Bought 84 C. weight of Sugar, which coſt 386 *l.* 12 *s.* but ſome Damage happening to the Sugar, I loſt by the Sale of the whole 60 *l.* The Queſtion is how it was Sold *per* Pound.

Say, as 84 C. weight to 326 *l.* 12 *s.* ſo is 1 *l.* to 8 *d.* $\frac{3120}{9408}$ the *Anſw.*

Q But

But in Case you would Gain a certain Sum *per Cent.* by the Sale of any Commodity. *Do thus,*

See what the whole value of your Goods will Gain, at the proposed Rate. And then work as in the first Example.

3. A Merchant buys 230 C. weight of Sugar, which cost 320 *l.* I demand how he may Sell the same *per* Pound, to gain after the Rate of 20 *l. per Cent.*

If 100 *l.* Gain 20 *l.* what shall 320 *l.* *Answ.* 64 *l.*

Then if 230 C. weight cost 384 *l.* what shall 1 *l.* cost? *Answ.* 3 *d.* $\frac{1488}{2576}$.

If you have Goods at one Price, and Sell them for a higher to be paid at a time; then to know what you Gain *per Cent. per Ann. Do thus,*

In the Compound Rule of Three Direct, *Let the price your Goods (or any part) cost you be the first Term, the time you trusted the second, the Gain for the whole (or any part of) the third, one hundred pounds the fourth, and 12 Months the fifth; then working according to the Directions in the said Rule, there will come out the Answer.*

Suppose a Druggist buys 6 *l.* of Ambergreese, which cost 250 *l.* this he Sells for

300 *l.*

300 *l.* to be paid 8 Months hence; the Question is what he gained, *per Cent. per Ann.* after this Rate?

	l.	*m.*	*l.*	*l.*	*m.*
If	250	8	50	100	12

Answ. 30 *l. per Cent. per Ann.*

---

300 *l.* to be paid 8 Months hence; the Question is what he gained, *per Cent. per Ann.* after this Rate?

l.	m.	l.	l.	m.
If 250 —	8 —	50 —	100 —	12

Answ. 30 *l. per Cent. per Ann.*

PART II.

Containing the

Reason and Demonstration

OF

ARITHMETICK

IN

Whole Numbers and Fractions,

BOTH

Vulgar and Decimal.

By William Alingham, Teacher of the Mathematicks.

LONDON:

Printed in the Year 1705.

THE DEMONSTRATION OF ARITHMETICK.

IN order to the Demonſtration of the following Operations in Arithmetick, the Notation of the following Characters muſt be throughly underſtood.

This ſign = placed between two Quanties, ſhows them to be equal as A=B, *ſhows that* A *is equal to* B.

This mark (+) placed betwixt two Quantities, denotes them to be added, as A+B, *ſhows that* A *is to be added to* B. Or it denotes the Sum of A and B.

This Character (—) placed between two Quantities, ſhows that the latter muſt be ſubſtracted from the former; as A—B *ſignifies that,* B *muſt be ſubſtracted from* A, or it denotes the difference betwixt A and B.

This Simbol (X) denotes the Quantitie on each ſide it to be multiplied, as $A \times B$ ſhows that A is to be multiplied by B, or it denotes the product of A and B, the ſame (that is the product) is alſo denoted by the Conjunction of Letters as they are in a word, thus CD notes the product of C multiply'd by D.

If two Quantities ſtand one under another thus $\frac{a}{b}$, it denotes Diviſion; that is, it ſhows that A is to be divided by B. Or more univerſally it denotes the Quote of A divided by B.

This ſign ($\surd$) denotes the ſquare Root of the Quantity following it, as $\surd B$ denotes the ſquare Root of B, and $\surd \overline{B+C}$ denotes the ſquare Root of the Sum of B and C, alſo $\surd \overline{BC}$ the ſquare Root of the Product of BC.

If the Number 3 ſtands before the radical Sign, it ſignifies the Cube Root, as $\sqrt[3]{B-D}$ denotes the Cube Root of the difference betwixt B and D.

Theſe four Points (::) placed between four Quantities, is the Note of Proportion; as if the four Quantities ſtand in this Order, A : B :: C : D they are thus to be read, A is to B, as C is to D.

Definitions,

Definitions, Corollaries, Axioms and Propositions, necessary for the following Demonstrations.

1. RAtio, is the *Habitude* or *Relation*, that one number hath to another.

2. In all *Ratio*'s there is only two Numbers, the Number which is referr'd is called the *Antecedent*, and the other to which it is referr'd is called the *Consequent*. As in the Comparison of 8 to 2, the *Antecedent* is 8, and the *Consequent* is 2.

3. The *Quantity* of any *Ratio* is found by dividing the Antecedent by the Consequent, as the Ratio of 8 to 2 is 4, and the Ratio of 2 to 8 is $\frac{1}{4}$, they are exprest Fraction wise thus $\frac{8}{4}$, and thus $\frac{2}{8}$.

Corollary 1. Hence arises a more clear Definition of *Ratio*, which is this, **Ratio** *is the Times, Time or part of a Time, that one Number contains another*; thus the *Ratio* of 6 compar'd to 2 is 3, but the *Ratio* of 2 compar'd to 6 is $\frac{2}{6}$. So that a great Number compar'd to a little Number hath a great *Ratio*, and a little Number to a great, has (tho' but small yet) some *Ratio*: For tho' the least Number contains not the greatest *one time*, yet it contains it some part

part of a time as in the Comparison of 1 to 10000000000 here, though 1 contains 10000000000 not one time, yet it contains it some part of a time, *viz.* *One Ten Thousand Millionth part*, whence 'tis Evident all Numbers have a *Ratio* one to another.

Def. 4. From the preceding *Corollary* it is manifest, that the value of a *Fraction* is only the *Quantity* of the *Ratio* of the *Numerator* compar'd to the *Denominator*.

Def. 5. If the Quantity of one *Ratio* be equal to the Quantity of another, then are those *Ratio*'s alike, and the Numbers are called *Proportional Numbers.* As if the Quote of 8 divided by 2, be equal to the Quote of 12 divided by 3, then are 8, 2, 12 and 3 *proportional Numbers*, and therefore as 8 : 2 :: 12 : 3.

Cor. 2. Hence to *double*, *treble*, &c. Ratio is only to *double*, *treble*, &c. the Antecedent of such *Ratio*. *Exam.* The Quantity of the *Ratio* of 6 to 2 is 3, now to double this *Ratio*, I double 6 the Antecedent it makes 12, this 12 divided by 2 the Consequent gives 6, which is double the former Quote of 6 divided by 2. The reason is plain, for two Numbers, one double, to the other divided by the same Number will have double

double the Quote, and consequently the *Ratio* is doubled.

Cor. 3. The *Ratio* is also *doubled, trebled, &c.* by *halving, thirding,* &c. the consequent of the *Ratio* as before in the *Ratio* of 6 to 2, here if I divide the Antecedent by 1, which is but half of the Consequent the Quote 6 is doubled to 3, the Quote of 6 divided by 2. For 6 must needs contain 1 double, the Number of times it doth 2.

Cor. 4. The contrary of these two *Corollaries*, and the reason of them is also Evident, *viz.* that if you would *Halve, Third,* &c. any *Ratio.* 'Tis but *halving, thirding,* &c. the Antecedent of such *Ratio,* thus the Quantity of the *Ratio* of 12 to 3, or $\frac{12}{3}$, is when halved but $\frac{6}{3}$, the later Quote being but half the former.

Cor. 5. The same is also performed by *doubling, trebling,* &c. the Consequent of the *Ratio*, as in the *Ratio* of 12 to 3, or $\frac{12}{3}$ is when *halved* after this method $\frac{12}{6}$, which is apparently but half the former Quote of 12 by 3.

Def. 6. *Continual Proportion*, is when the intermediate Term betwixt the first and last is taken twice, as 2 : 4 : 8 : 16 are in continual

tinual Proportion, for 2 is to 4, as 4 is to 8, so is 8 to 16.

AXIOMS.

1. *Things* equal to the same Third, are equal one to another.

2. If to equal *Numbers* or *Quantities*, you add equal *Numbers* or *Quantities*, the wholes shall be equal.

3. If from equal *Quantities*, you take away equal *Quantities*, the Remainder shall be equal.

4. Equal *Numbers* or *Quanties*, Multiplied by equal *Numbers* or *Quantities*, will have equal Products.

5. Equal *Quantities*, divided by equal *Quantities*, will have equal Quotes.

PROPOSITIONS.

Prop. 1. If four Numbers are Proportional, the Product of the Means shall be equal to the Product of the Extreams.

Demonstration. Let the Numbers be 8 : 6 :: 4 : 3 then (p. def. 4. 5) $\frac{8}{6} = \frac{4}{3}$ also $\frac{8 \times 3}{6} = 4$ (p. ax. 4) and $8 \times 3 = 4 \times 6$ (p. ax. 4) *which was to be Demonstrated.*

After the same manner it is prov'd, that if 3 Numbers are in continual Proportion, the

the Product of the first and third is equal to the Square of the second.

Prop. 2. Ratio's which are equal to a Third, are also equal one to another.

Dem. Admit $\frac{12}{4}=\frac{9}{3}$, and $\frac{6}{2}=\frac{9}{3}$, then I say that $\frac{12}{4}=\frac{6}{2}$. For $\frac{12}{4}=\frac{9}{3}=\frac{6}{2}$, therefore $\frac{12}{4}=\frac{6}{2}$, (p. Ax. 1.) *which was to be Demonstrated.*

Prop. 3. If a Number Multiply two Numbers, the Products shall have the same Ratio to each other, as the Numbers themselves had.

Dem. Suppose 6 and 8 are the Numbers to be multiplied, and 3 the Multiplior, the *Ratio* of 6 to 8 is $\frac{6}{8}$. then Multiplying $\frac{6}{8}$ by 2, 'twill give $\frac{12}{16}$, which is equal to $\frac{6}{8}$. For to double the Antecedent of the *Ratio*, doubles the *Ratio* ; but to double the Consequent halve's the *Ratio*. Now to double it first, and then to half it, still keeps the Ratio the same, therefore the Ratio of 6 to 8 is equal to that of 12 to 16. *which was to be Demonstrated.*

Upon this Proposition depends the Demonstration of most Operations in Fractions.

Of Number, and its Notation.

NUmber is nothing elſe but the *Multitude* of any ſort of Things.

Notation of Numbers, vulgarly called *Numeration*, is that which teaches to expreſs Numbers by *Words* and *Characters*.

One, or an *Unit*, is the leaſt of all Characters, for *Number is only a Collection of Units*; and therefore, if to a Unit be added another Unit, it makes another Number, and if to this ſecond Number be added another Unit, it makes a third Number differing from the former, ſo that by the continual adding of Unity, there will ariſe an infinite variety of Numbers for the Expreſſing of which were there requir'd, the like variety of *Characters* 'twould be extream difficult; but this difficulty is removed by a very eaſie Method of placing them, which for its excellency and uſefulneſs may deſervedly be accounted amongſt the moſt noted Inventions of Mankind, and as the learned Dr. *Wallis* ſays, if duly conſidered, may ſeem to be more than bare *Humaine Diſcovery*.

The Characters by which all *Numbers* are Expreſt, as I have hinted before are ten, one of which, *viz.* (o) ſignifies nothing of it ſelf, the others have not only ſingle Values of themſelves, but have other Values accord-

accordingly to their places which they accidentially Possess.

The Invention of these Characters, as *Tradition* tells us, is owing to the *Arabians*, and if you will believe *Aristotle*, the reason of our using neither more nor less than 10. is from the *Denary* Number of our Fingers

In all Numbers, every Figure hath a place.

The *first Place* next the Right-hand is the place of Units, and any Number there standing signifies only its own Single-value, the *Figure* in the *second Place*, is the place of Tens, and denotes ten Times its own Value; that is, 'tis ten Times as much as if it stood in the first Place. The *third Figure* is also ten Times as much as if it stood in the second Place, and one hundred Times as much as if it stood in the first Place, and so it goes on increasing every Figure, being ten Times as much as if it stood in the place before it, *that is*, in the next place to the Right-hand.

From the foregoing Explanation will follow these Consequents.

First, That every Figure hath two Values, *viz.* its own, and another, according to the place it stands in.

Secondly,

Secondly, That if one Figure be placed before any Number, the value of that Number is encreaſed ten Times; if Two, a hundred Times; if Three, a Thouſand, and ſo on, in a *Tenfold Proportion*. Let the Number 436 be propoſed, then if I place 5 before it every Figure, thereof is advanced a place higher, ſo that 6 ſtandeth in the ſecond, 3 in the third, and 4 in the fourth Place, therefore the Value of every Figure is encreaſed ten Times as much, and conſequently the value of the whole is ten Times as much as 'twas before. beſide the value of the Figure added; if two Figures, ſuppoſe 57 be ſet before the Number 436, every Figure aſcendes two places higher, and therefore the value of each Figure, and conſequently the value of the whole is one hundred Times as much. *See the Figures in the Margin*.

$$436\left\{\begin{matrix}5\\57\end{matrix}\right.$$

Thirdly, That if before two Numbers, ſuppoſe 24, and 8 be placed an equal Number of Cyphers, then are thoſe Numbers increaſed an equal Number of Times, for one Cypher ſet before two Numbers makes them ten Times as much, and another before that makes it ten Times as much as the laſt, and therefore an hundred Times as much as the Firſt.

Fourthly,

Fourthly, Of two Numbers; that is, the greatest that hath most Figures in it, for if a Cypher be put on the Right-hand of 1 it makes it ten, which is bigger than any Number noted by a single Figure.

Fifthly, That of Numbers containing an equal Number of Figures; that is, the greatest which hath the last Figure greatest. This is Evident from the first and second Consequent, where, if to 1 you put two Nines, and if to 2 you put two Cyphers, the two with Cyphers is greater than the 1 with two nines.

This manner of Notation being well considered, the reason of the Operations in *Addition*, *Substraction*, *Multiplication* and *Division* will be Axiomatically Evident. And therefore I shall not insist upon the Demonstration of any of them, but proceed to those that are more Intricate beginning first with the Rule of Three.

The Demonstration of the Rule of Three Direct.

IN the Rule of Three Direct, where three Numbers are given to find a fourth in direct Proportion, the Rule is, *Multiply the second Number by the third, and divide the Product by the first, the Quote is the fourth Term or Answer.*

For *Exam.* If 8 Pounds buy 4 Sheep, how many will 12 Pounds buy? *That is,* 8 : 4 :: 12 to some other Number, suppose a. therefore (*p. prop.* 1st) $8 \times a = 4 \times 12$, and dividing both sides of the Equation by 8, the Quote (p. ax. 5) will be $a = \frac{4 \times 12}{8} = 6$ the fourth Proportional, or Answer. From which the reason of finding the fourth Proportional, or Answer, by the aforesaid Rule is evident. For since (*by prop.* 1.) the product of the second and third, is equal to the Product of the first and fourth. If therefore I divide the product of second and third by the first Term, the quote will be such a Number as will Multiply the first, and make that Product equal to that of the second

ſecond and third, as is Evident from *Diviſion*, and therefore is the fourth Proportional or Anſwer required.

The Demonſtration of the Rule of Three Reverſe.

IN this Caſe the Rule is, *Multiply the firſt and ſecond Terms together, and divide the Product by the third, the Quote is the fourth Proportional or Anſwer.*

For *Exam.* Suppoſe 30 Men build a Houſe in 10 Days, in how many Days will 15 Men build the ſaid Houſe?

The Queſtion ſtated according to the general Rule, (which ſays, *That the firſt and third Number muſt be of one Name, &c.*) will ſtand thus,

M	D	M
30	10	15

Here working according to the direct Rule, the Anſwer will be but 5, which is apparently falſe, for if 30 Men require 10 Days, then 15 will require 20 Days.

But if you compare them Reciprocally, *viz.* the second Time to the first Men, and the first Time to the second Men, the Proportion will be direct; *that is*, if you will put the first Term in third Place, and the third Term in the first Place, you change this *Reverse* to a *direct Proportion*, and then the Demonstration will be as before.

For changing it 'twill stand thus, 15 : 10 :: 30 : a then (*p. prop.* 1.) $a \times 15 = 10 \times 30$, and (*p. ax.* 5.) $a = \frac{10 \times 30}{15} = 20$, which 20 is the Answer to the Question, and you see is found by Multiplying the first by the second, and dividing the Product by the third, when the Question is stated according to the general Direction.

The Demonstration of the Compound Rule of Three Direct.

Exam. SUppose 100 *l.* in 12 Months gain 6 *l.* Interest, what shall 400 *l.* gain in 24 Months? ——————

To state the Question do as followeth.

If 100 *l.*—12 Mon.—6 *l.*—400 *l.*—24 Mon.

Here

Here working according to the Direction given in this Rule, the Answer will be,

$$\frac{6 \times 400 \times 24}{100 \times 12}$$

But Questions in the Compound Rule of Three may be solv'd, by the Single Rule of Three at two Operations.

Thus, Say as 12 *Mon.* —— 6 *l.* —— 24 *Mon.* *Answ.* $\frac{6 \times 24}{12}$

Then, if 100 *l.* —— $\frac{6 \times 24}{12}$ —— 400 *l.* $\frac{100}{1}$) $\frac{6 \times 24 \times 400}{12}$ ($= \frac{6 \times 24 \times 400}{100 \times 12}$ *Answer*, Which proves the Compound Rule of Three direct.

The Demonstration of the Compound Rule Reverse.

THE Compound Rule Reverse may also be solv'd by two Operations of the Single Rule of Three, only one will be Direct, and the other Inverse.

As in this *Example*, If 20 Acres Graze 32 Oxen for 18 Days, how many Days will 30 Acres last 40 Oxen.

Here stating and working the Question, according to the Direction given for operating in this Rule, the *Answer* will be $\frac{32 \times 30 \times 18}{20 \times 40}$.

For *First*, By the Single Rule Direct.

If 20A———32Ox———30A
$\frac{32 \times 30}{20}$ *Answer.*

Secondly, By the Single Rule of Three Reverse.

If $\frac{32 \times 30}{20}$———18———40
That is $\frac{32 \times 30 \times 18}{20 \times 40}$ the *Answer*, and the thing to be Demonstrated.

Of Simple Interest.

IN Simple Interest these 4 Things are to be considered. *First*, The *Principal* or *Money* put out. *Secondly*, The *Rate* 'twas lent at: *Thirdly*, The *Time* it lay. And *Fourthly*, The *Amount*; *that is*, the *Principal* and *Interest* together.

When therefore a Question is proposed in simple *Interest* or *Rebate*, there is always three

three of these 4 Things given to find the fourth. Now for the more better solving Questions of this Nature, I shall denote the fore-going particulars as followeth.

Exam. What's the Interest of 250 *l.* for 2 Years $\frac{1}{2}$ at 6 *per Cent. per Ann.* put $p = 250$ the Principal or Sum put out; $t = 2\frac{1}{2}$ the time of Continuance in Years or Parts of a Year; $g = .06$ the gain of 1 *l.* in one Year; $u = 37$ *l.* 10 *s.* the Amount; *that is*, the Sum of Principal and Interest together.

This being premised, Note.

That 1 Year : g :: t : tg the Interest of 1 *l.* for the time proposed. So that $t + tg$ is the amount of 1 *l.* for the time proposed.

And then as 1 *l.* is to its amount for any time, so is any other principal to its amount for the same time.

That is $1 : 1 + gt :: p : p + pgt = u$ which is the general *Theorem* for solving all Questions of this Nature.

For since $u = p + ptg$ therefore $p = \frac{1+tg}{u}$ which is the Cannon or *Rule* for Rebate.

So also $g = \frac{u-p}{pt}$ which finds the Rate 'twas lent at. Lastly $t = \frac{u-p}{pg}$ finds the Time it lay.

Of Purchasing Annuities and Pensions at Simple Interest.

THE Business of computing the value of *Annuities* or *Pensions*, according to Simple interest at any Rate *per Cent. per Ann.* is what may be worth our Enquiry; tho' not of such Importance as that which finds their value according to Compound Interest, the reason of which is Evident, because at Simple Interest an Estate may be computed to be worth 200 Years Purchase, which is a great deal more than any Estate will ever sell for here in *England*.

This being premised take this *Example*, *Suppose an Annuity of* 200 *l.* per Ann. *to continue* 4 *Years to be sold, what is it worth in ready Money, allowing the Purchaser* 6 *l.* per Cent. per Ann. *Simple Interest*.

The things to be considered and noted for the Solution of this, and the like Questions, are as followeth.

a=200 *l.* the Annuity or Annual Income.
t=4 the time of continuance in Years or Parts of a Year.
g=.06 the gain of 1 *l.* for a Year.
p=703 *l.* 4 *s.* 6 *d.* *near*, the price or present worth.

The

The things thus noted ſay, as $1 : g :: a : ga$, ſo that ga is the Intereſt of 200 *l.* for one Year.

Then 'tis evident, that at the end of the firſt year, I ought to receive 200 *l.* the Annuity only, at the end of the ſecond Year 200 *l.* with the Intereſt of 200 *l.* *as in the following Table.*

a Firſt Year.
$a+ga$ Second Year.
$a+2ga$ third Year.
$a+3ga$ Fourth Year.

Which $a+3ga$ is equal to $a+tga-ga$, which is generated by Multiplying ga by $t-1=3$.

Now the Sum of all thoſe *Annual Receipts*, is the whole forbearance or amount of the Annuity, according to Simple Intereſt, which *Sum* is gotten by Multiplying the Sum of the firſt and laſt Terms, by half the Number of Terms; the Product $\frac{2ta+ttga-tga}{2}$ is the whole forbearance of the *Annuity*.

Then $1+tg : 1 :: \frac{2ta+ttga-tga}{2} : \frac{2ta+ttga-tga}{2+2tg}$ which gives the *Theorem* for finding the price or preſent worth. And, becauſe $\frac{2ta+ttga-tga}{2+2tg}=p$ therefore $2ta+ttga-tga=2p+2tgp$, which is the general *Theorem* from which all others may be rais'd for ſolving all Queſtions of this Nature.

For

For if $\frac{2ta+ttga-tga}{2+2tg}=p$ then $2ta+ttga-tga=2p+tgp$, and therefore $ttga-tga-2tgp=2p-2ta$, and consequently $g=\frac{2p-2ta}{tta-ta-2gpt}$ which finds the gain or rate *per Pound, per Ann.* the purchaſe was made at.

And reaſſuming tbe firſt *Theorem*, and tranſpoſing the Terms you will find that $a=\frac{2p+2gpt}{2t+ttg-tg}$ which gives the Annuity or Penſion:

Laſtly, To find the Time any propos'd Annuity ought to continue to ſatisfy any given *Fund*. Let the firſt *Theorem*, viz. $2ta+ttga-tga=2p+2pgt$ be again reaſſumed, and let $ga=b$, and $2a-ga-2pg=c$, then $tt+\frac{ct}{b}=\frac{2p}{b}$ and $t=\sqrt{\frac{2p}{b}+\frac{cc}{4bb}}-\frac{c}{2b}$ which finds the Time in which any propoſed Annuity will pay off any Fund or Loan within its reach, computing it at any Rate, and Simple Intereſt.

Of

if £1 in six years, £1:0:4:4 what £325

Of Compound Interest.

IN Compound Interest these 4 Things are to be considered, First, the *Principal* or *Sum* forborn; Secondly, the *Rate* 'twas lent at; Thirdly, the *Time* it lay; and Fourthly, the *Amount*; *that is*, the *Principal* and *Interest* both together.

And therefore, when a Question is proposed in Compound Interest, there is always 3 of these four particulars given to find the fourth; which particulars, for the more ready expressing the several Parts, both given and sought in Questions of this Nature, I shall denote by the following Characters.

Exam. What's the amount of 325 *l.* put out at Interest for 6 Years at 6 *l.* *per Cent. per Ann.* Compound Interest.

p=325 *Principal*, or Sum forborn.
t=6 *Time* in Years, or parts of a Year.
r=1.06 *Rate*, or amount of 1 *l.* for one Year.
a=461 *l.* 00*s.* 4 *d.* $\frac{3}{4}$ amount of the principal for the given Time and Rate.

Note by another way I make it £ s d 461: 0: 3¾

I can make it but
£ s d
460: 15: 1: 4, & judge it wrong printed
by my way I find ¼ at 6 £ (out compound in six years
interest, facit — 1: 8: 4: 4, & I do not
understand ye: above Characters

This

This being noted, say, as $1 : r :: r : rr :: rr : rrr :: rrr : rrrr$, &c. which is, as 1 *l.* to its amount, so is that amount to the amount of 1 *l.* at 2 Years, two half Years, or two Quarters end, according as the payments are made.

Then, as $1 : r^t :: p : a$ whence $pr^t = a$, which is, as 1 *l.* to its amount for any time; so is any given principal to its amount for the same time.

Note, That t is the Index of the power of r, and shows how oft r is to be involv'd in it self, being equal to the number of Payments.

From the two foregoing Proportions, the general Theorem, *viz.* $pr^t = a$ is raised, and from it 'tis easie to conceive how by having any three of these Members given, the fourth may be found.

For *First* $pr^t = a$ finds the amount; *Secondly*, because $pr^t = a$ then $p = \frac{a}{r^t}$ this finds the principal.

Again, because $pr^t = a$ then $r^t = \frac{a}{p}$ and consequently $r = \sqrt[t]{\frac{a}{p}}$ which finds the Rate 'twas lent at.

Lastly, To find t the Time, because $pr^t = a$ then $r^t = \frac{a}{p}$. That is, divide the amount by the Principal, the Quote is some power of r, to find which divide the said Quote conti-

continually by r, till the Quote is 1, the Number of such Divisions will be t, the time in *Years*, *Halves*, or *Quarters*, according as the Payments were.

Of Purchasing Annuities and Pensions in Reversion, according to Compound Interest.

THE business of Purchasing Annuities after this manner, depends upon finding what present Money should be paid for any Sum of Money due, 1, 2 or more Years hence.

For Instance, *suppose*, an Annuity to continue 2 Years, 'tis evident, did it continue but 1 Year the present worth of it would be so much, as if put out for a Year, would amount to one Year's Rent, and that the present worth of the Rent received at the end of the second Year is so much Money, which if put out will in two Years time (reckoning Compound Interest) amount to one Year's Rent, the Sum of these two present

ſent worths is the real and true Value of the Annuity; *that is*, 'tis the price or preſent worth of it. Therefore the preſent worth of the ſecond Years Penſion, is only the preſent worth of the firſt Years Penſions; for 106 *l.* to be paid two Years hence, is of the ſame value with 100 *l.* to be paid one Year hence (Rebating according to Compound Intereſt) and 100 *l.* one Year hence is worth but 94 *l.* 06 *s. near.* And 106 *l.* one Year hence is worth but 100 *l.* preſent; ſo that an Annuity of 106 *l.* to continue 2 Years, is worth in ready Money 194 *l.* 06 s.

Hence the Solution of Queſtions of this Nature, depends upon the finding of a rank of Numbers in a *decreaſing Geometrick Progreſſion*, whoſe firſt and greateſt Term is the Annuity or Penſion.

This being premiſed, the particulars are denoted as followeth.

Exam. What's the preſent worth of an Annuity of 350 *l.* payable Yearly, to continue 7 Years at 6 *l. per Cent. per Ann.* compound Intereſt.

p=350 *l.* Yearly (half Yearly, *&c.*) Penſion, and is the firſt or greateſt Term.

t=7

$t=7$ The time of continuance in Years, or parts of a Year, and is the Number of all the Terms.

$a=1.06$ The amount of 1 *l.* for one Year, (half Year, *&c.*) and is the common Ratio of all the Terms.

$z=1953$ *l.* 16 *s.* 8 *d.* the Sum of all the Terms, and is the price or present worth of such Annuity.

This granted, *say as*, $a : 1 :: p : \frac{p}{a} :: \frac{p}{a} : \frac{p}{aa} :: \frac{p}{aa} : \frac{p}{aaa}$ the last of which will be $\frac{p}{aaaaaaa} = \frac{p}{a^t}$.

Hence arises this continued Geometrick Progression, *viz.* $p : \frac{p}{a} : \frac{p}{aa} : \frac{p}{aaa} : \frac{p}{aaaa} : \frac{p}{aaaaa} : \frac{p}{aaaaaa} : \frac{p}{aaaaaaa} = \frac{p}{a^t}$ the Sum of which Terms, except p the first is the present worth of the Annuity. To find which 'twill hold, as one Antecedent to its Consequent, so is the Sum of all the Antecedents, to the Sum of all the Consequents; *that is*, as $p : \frac{p}{a} : : z - \frac{p}{a^t} : z - \frac{p}{a}$ therefore $zp - \frac{pp}{a} = \frac{zp}{a} - \frac{pp}{aa^t}$ then Multiplying all by a, 'twill be $zpa - pp = zp - \frac{pp}{a^t}$ and then dividing both sides of the Equation by p, 'twill be $za - p = z - \frac{p}{a^t}$ which by a double Transposition becomes $za - z = p - \frac{p}{a^t}$ this divided by $a - 1$ gives $z = \frac{p - \frac{p}{a^t}}{a - 1}$ or reducing it to one entire Fraction, it makes $a - 1\ \frac{pa^t - p}{aa^t - a^t} = z$. which is the *general Theorem* for solving all Questions of this Nature, and finds the price or present worth of the Annuity.

In

In words thus, *Multiply the amount of one Pound for the time proposed by the Pension, and from the Product take the Pension, and note the Remainder. Then Multiply the amount of* 1 *l. for the time by the rate, and from the Product take the amount of* 1 *l. for the time, by this Remainder divide the forenoted Remainder, the Quote is the present worth.*

Secondly, Reassuming the aforesaid Theorem, *viz.* $\frac{pa^t - p}{aa^t - a^t} = z$ then $pa^t - p = zaa^t - za^t$ and consequently $p = \frac{zaa^t - za^t}{a^t - 1}$ or $p = \frac{a^t \times \overline{a - 1 \times z}}{a^t - 1}$ which finds the Annuity or Pension, and is in words thus.

Multiply the amount of 1 *l. for the time proposed, by the Rate* -1, *and this last product by the purchase Money; this second Product divide by the amount of* 1 *l. for the time proposed*-1. *The Quote is the Pension sought.*

Thirdly, To find *t* the time of Continuance, let the foregoing *Theorem*, Viz. $\frac{pa^t - p}{aa^t - a^t} = z$ be again reassumed, then $pa^t - p = zaa^t - za^t$ then $pa^t - zaa^t + za^t = p$ and therefore $a^t = \frac{p}{p - za + z}$ and consequently $t = \frac{a^t}{a} :: = \frac{p}{p - za + z}$ which finds the time of Continuance.

In words thus, *To the Pension add the present worth, and from that Sum take the Product of the present worth by the amount of* 1 *l. for a Year, then divide the Pension by this Remainder, the Quote is equal to the amount*

of

of 1 *l. for the time proposed. Then divide this Quote continually so often by* a, *till at last the Quote be* = a, *the Number of those more* 1 *is equal to* t *the time.*

Fourthly, For the Theorem where *a* the Rate of Interest is requir'd, it amounts to a Compound Equation of three Terms, whereof the first contains a power of the unknown Quantity, whose *Index* is equal to the Number of Years increased by 1. The second a Power of the unknown Quantity, whose *Index* is equal to the Number of Years; the third an absolute known Quantity. Now though the common Methods of solving Equations by *Approximations* might solve this, yet considering how Laborious the work would be, I forbear giving any particular instance of it, which I do the rather, because I am inform'd, that Dr. *Hally*, *Astronomy Professor at* Oxford, and *Mr*. D. Moivre, *Fellows of the Royal Society*, have seperately considered this Case, and are ready to publish what they have done in this Matter. Now the value I have for these is such, that I should think it a Presumption to meddle with that they have undertaken, and of which the Publick will receive the benefit in a short time.

The reason why Annuities in Fee-simple are worth 20 Years Purchase, laying out your Money at 5 *l. per Cent. per Ann.*

From what before has been said 'tis Evident, that when a Fee-simple; *that is*, an Annuity to be purchased for ever, the Terms of the Progression are infinite, because *t* which denotes their Number is infinite; and in an infinite Progression, the last or least Term is nothing. From which Supposition it will follow, that the Sum of an infinite Progression will be a finite Quantity.

For suppose 40 *l.* Annuity to continue for ever be to be sold, what is it worth in ready Money.

In this *Example*, I shall denote the particulars, as followeth;

$\frac{p}{a} = \frac{40}{1.05}$ the first or greatest Term.
$\frac{p}{at}$ the last and least Term.
z the Sum of all the Terms.
$a = 1.05$ the Ratio of the Terms.

This premis'd, it is prov'd, that as one Antecedent is to its Consequent, (or the Ratio to Unity) as the Sum of all the *Antecedents*, to the Sum of all the *Consequents*.

But, because the Progression is infinite the last, or least term, *viz.* $\frac{p}{at}$ is nothing, therefore,

$a : 1 :: z : z - \frac{p}{a}$
then $z = za - \frac{p1}{a}$
that is $za = zaa - pa$
Or $z = za - p$
that is $z = \frac{p}{a-1} = 800$

But 800 *l.* is equal to 20 times one Year's Rent of the Annuity, laying out your Money at 5 *l. per Cent.*

From this Theorem $z = \frac{p}{a-1}$ several Consequents will follow.

First, That in giving 20 Years Purchase for any Annuity for ever, you have but 5 *per Cent.* for your Money.

Secondly, If you give above 20 Years Purchase, you have not 5 *per Cent.* for your Money.

Thirdly, If you would lay out your Money to have 6 *per Cent.* for it, you must give but 16 Years, and about 2 Months Purchase.

Lastly, From the aforesaid Theorem you may easily Calculate a Table, that will show you the present worth of any Fee-simple Estate. Provided you would lay out your Money at any Rate of Interest.

The Demonstration of Fellowship without Time.

THE Demonstration of *Single Fellowship* is self Evident. For as the whole Stock, to the whole gain or loss, so is any part of the Stock, suppose $\frac{1}{2}$. $\frac{1}{3}$. $\frac{1}{4}$ *&c.* to the like part of the gain or loss.

Admit by Trading with 1000 *l.* Stock, we gain 100 *l.* then 'tis Evident, he that put in 500 *l.* which is half the Stock, must have 50 *l.* which is half the gain. And he that put in 250 *l.* which is one Quarter of the Stock, must have 12 *l.* 10 *s.* which is $\frac{1}{4}$ of the gain, and so whatever share of the Stock you put in, such like part of the gain must be received, and this part of gain or loss is obtain'd by working the Question according to the Rule of Three Direct, *which has been already demonstrated.*

The

The Demonſtration of Fellowſhip with Time.

IN this Rule we are to prove, that each particular *gain* or *loſs* is in ſuch Proportion as the Sum of Intereſt Money, that might have been gain'd at any Rate *per Cent.* Simple Intereſt, by each of their Stocks in their reſpective Times.

Take this Example; *A* and *B* trade together, *A* put in 100 *l.* for 4 Months, *B* put in 50 *l.* for 16 Months, they gain 30 *l.* what muſt each Man have of the gain.

100 at 4——400
50 at 16——800

1200

1200——30——400
30

1200)12000(10 *A*'s part.

1200———30———800
30
———
1200)24000(20 *B*'s part.

This premiſed, I am now to prove that one's Stock, Multiplied into his Time, is to the others Stock Multiplied into his Time, as the ſhare of one, to the ſhare of the other.

$$\text{For } 1200 : 30 \begin{cases} 400 : 10 \\ 800 : 20 \end{cases}$$

Therefore 400 : 10 :: 800 : 20, and therefore 400 : 800 : : 10 : 20

This granted, 'tis Evident, that if I prove, that their reſpective Intereſts are to each other, as the product of one Stock and Time, to the Product of the other Stock and Time; I prove what's required. Becauſe each Stock Multiplied by its time, is as their true Shares.

In order to this, ſuppoſe the Intereſt of 100 *l.* for 4 Months to be 3 *l.* then the Intereſt of 50 *l.* for the ſame time is $\frac{50\times3}{100}$. Now to get the Intereſt of 50 *l.* for 16 Months, ſay, If 4 Months give $\frac{50\times3}{100}$ what will 16 Months give? *Anſwer*, $\frac{3\times50\times16}{100\ 4}$.

Hence

Hence *A*'s Intereſt, is to *B*'s Intereſt, as 3 to $\frac{3 \times 50 \times 16}{100 \times 4}$, and therefore, if I prove that *A X* 4 is to *B X* 16 as 3 to $\frac{3 \; 50 \; 16}{100 \times 4}$ the thing is done; becauſe their Shares are in ſuch Proportion as their Stocks Multiplied by their reſpective times.

To do this, Multiply both Terms by 100 *X* 4, then will their Products, *viz.* 100 *X* 4 *X* 3 be in the ſame Proportion as theſe Quantities were; but 3 is a common Multiplior, therefore expunge it in both Terms, and the remaining Quantities will be in the ſame Proportion, that is the ſhare of *A*, is to the Share of *B*, as 100 X 4 to 50 X 16, *which was to be Demonſtrated.*

The Demonſtration of Aligation Medial.

THE Demonſtration of *Aligation Medial*, is but little more than the Demonſtration of the Rule of Three Direct.

For ſuppoſe 50 Gallons of white Wine, at 3 *s. per* Gallon, be mixed with 30 Gallons of Canary at 9 *s. per* Gallon, what's the Price of a Gallon of this Mixture.

'Tis Evident firſt, that the 50 Gallons of White will amount to 150 Shillings, and the 30 Gallons of Canary to 270 Shillings; *that is*, the whole 80 Gallons will amount to 420 Shillings.

Then, if 80 Gallons cost 420 Shillings, what shall one Gallon cost? Therefore $\frac{420}{80}$ = the price of one Gallon of ſuch Mixture.

The Demonſtration of Aligation Alternate.

THIS Rule of *Aligation Alternate* is of vaſt Extent, and will ſolve variety of Queſtions; but yet, as 'tis delivered by moſt Writers of Arithmetick, 'tis very Imperfect, for the following Reaſons.

Firſt, It gives various Solutions to ſeveral Queſtions.

Secondly, It gives imperfect Solutions; *that is*, ſuch as do not anſwer the preſent Occaſion.

Thirdly, In ſeveral Caſes it will give more than one Solution to a Queſtion, and yet not all the Solutions, nor Determination thereof.

And therefore, I ſhall not inſiſt upon a ſtrict Demonſtration of this Rule, in all its *Applications*, *Limitations* and *Anſwers*, but only in Relation to the common Queſtions that are ſolv'd by it.

This

This being premiſed, take the following *Example*, ſuppoſe I would mingle Wheat at 12 *s.* the Buſhel, with Rye of 3 *s.* the Buſhel. ſo that I might ſell a Buſhel of the Meſtling for 5 *s.* and make as much Money of the mixture, as if each Quantity was ſold at its own price, the Queſtion is, how many Buſhels of each ſort of Corn muſt be in this mixture.

$$5\begin{Bmatrix}12\\3\end{Bmatrix}\begin{matrix}2\\7\end{matrix}$$

The Anſwer is, 2 Buſhels of Wheat, which comes to 24 *s.* at 12 *s.* the Buſhel, and 7 Buſhels of Rye, which comes to 21 *s.* at 3 *s.* the Buſhel, the Sum of which is 45 *s.* Now the Sum of the Buſhels of Wheat and Rye make 9 Buſhels, which at 5 *s.* a Buſhel, the mean Price comes to 45 *s.* as before.

Whence you ſee, that the Propoſition *Aligation Alternate* requires to be Demonſtrated, is this.

There are 3 Numbers, *W* the greateſt, *M* the mean, *R* the leaſt; if the difference betwixt the *mean* and *greater* be multiplied by the *leſſer*, and the difference betwixt the *mean* and *leſſer* be Multiplied by the *greater*, the Sum of theſe Products ſhall be equal to the Sum of thoſe differences Multiply'd by the *mean*. *See the Work.*

Mean

Mean price	Ext. price	Dif. plac'd Alternately	
M	W	$M-R$	$WM-WR$
	R	$W-M$	$RW-RM$

Here $M-R$ is the Bushels of Wheat, which if Multiplied by W, the price of a Bushel of Wheat, will give $WM-WR$ the price of those Bushels of Wheat; so also $W-M$ is the Bushels of Rye, which if Multiplied by R the price of a Bushel of Rye will give $WR-MR$ the price of those Bushels of Rye. The sum of those Products, *viz.* $WM-WR+WR-MR$ or $WM-MR$ (for WR is destroy'd) will be equal to the Sum of the Differences, *viz.* $M-R+W-M$, or $W-R$ Multiply'd by M, which makes $WM-MR$ the same as before.

The reason why the Differences are Alternately plac'd, is, because they are to be Multiply'd by the contrary Number; *that is*, the difference betwixt M and R is to be Multiply'd by W, and the difference betwixt W and M is to be Multiply'd by R.

Therefore $M-R$ is the Number of Bushels of Wheat, and $W-M$ the Number of Bushels of Rye, that must be taken to make the Mestling.

If

If there be ſeveral Things of different prices given to be mixt as aforeſaid, the Demonſtration will be more perplex, but not different from the former; I ſhall therefore omit proceeding further in this, not only for the perplexity of it, but becauſe both the Solution and Demonſtration of Queſtions of this Nature are eaſier done, and clearer ſeen, from an *Algebraick Operation.*

The Book ſwelling more than I expected, I ſhall omit the Demonſtration of the Rule of *Falſe*, otherwiſe I muſt leave out ſome that will be more uſeful and ſerviceable in Practice; beſides, without ſome Knowledge in Algebra, the Demonſtration will be ſomething hard to acquire.

The

The Demonstration of Vulgar Fractions.

IN order to the more clear apprehending the Demonstration hereof, I must make a short Repetition of what has been already said.

First, That a Fraction is a part or parts of some Divisible Integer, and is represented by two Numbers, the one above, the other beneath a line thus $\frac{2}{5}$. 2/5

The Number placed below the Line, is called the Denominator, and shows what parts the Unit is broke into.

The Number above the Line is called the Numerator, and shows how many of those parts are to be taken in the Fraction; as the Fraction $\frac{2}{5}$ denotes two such parts, as the Integer contains 5.

2/5

From this Method of expressing Fractions, these *Consequents* follows.

First, Every Fraction, is to its whole an Unite, as the Numerator is to the Denominator.

Secondly,

Secondly, That if the Numerator be { greater, equal or leſs } then the, Denominator. The Fraction is accordingly greater, equal or leſs, than its whole an *Unite*. The firſt and ſecond of theſe kinds are called *improper* Fractions, the laſt are termed *Proper*.

Thirdly, That Fractions are not to be eſtimated by the greatneſs of their Numbers by which they are expreſs'd, but by the Proportion the Numerator bear to their Denominators.

Fourthly, That Fractions, whoſe Numerators to the Denominators bear the ſame Proportion, are equal as $\frac{1}{2}$, $\frac{3}{6}$, $\frac{10}{20}$.

Fifthly, That every Fraction is the Quote of the Numerator, divided by the Denominator, this granted, I ſhall begin with

Reduction the Firſt.

This is ſo clear from the nature and manner of Expreſſing a Fraction, as alſo from the firſt Conſequent, that it needs no farther Demonſtration.

Reduction

Reduction the Second.

The Proof of this is a conſequent from that of Multiplication, and therefore I refer it to that place.

Reduction the Third.

Teaches to abbreviate a Fraction, by dividing both Numerator and Denominator without a Remainder.

This is Evident from the 3d Propoſition, for ſuppoſe $\frac{9}{12}$ to be reduced to its loweſt Terms, here dividing 9 by 3, and 12 by 3, there ariſes 3 and 4, which 3 has to 4 the ſame Proportion that 9 has to 12, therefore by the fourth Conſequent $\frac{9}{12} = \frac{3}{4}$ *which was to be Demonſtrated.*

Reduction the Fourth.

Teaches to reduce Fractions of divers Denominations, to one Denomination having the ſame Value; for doing of which, the *Rule is*,

Multiply all the Denominators for a common Denominator, and each Numerator into all the Denominators, except its own, for a Numerator.

Suppoſe $\frac{3}{4}$ and $\frac{2}{7}$ were given to be Reduced.

Suppose $\frac{2}{3}$. $\frac{3}{4}$. $\frac{4}{5}$ from the Operation according to the Rule they will ſtand thus, $\frac{2\times4\times5}{3\times4\times5}$. $\frac{3\times3\times5}{3\times4\times5}$. $\frac{3\times4\times4}{3\times4\times5}$. *that is*, $\frac{40}{60}$. $\frac{45}{60}$. $\frac{48}{60}$ which Fractions are by the 3d Propoſition, and 4th Conſequent, equal to thoſe given.

Reduction the Fifth

This is proved in reducing a Vulgar Fraction to a Decimal.

Addition and Subſtraction of Fractions Demonſtrated.

THE Fractions, whoſe Sum or Difference is required, muſt be reduced to Fractions of the ſame Denomination. And then according to the Rule, the $\left\{\begin{array}{l}\text{Sum}\\ \text{Difference}\end{array}\right\}$ of the Numerators placed over the common Denominator, is the $\left\{\begin{array}{l}\text{Sum}\\ \text{Difference}\end{array}\right\}$ of the Fractions requir'd.

Exam. What's the Sum and Difference of $\frac{3}{8}$ and $\frac{2}{7}$.

The

The Fractions reduced to the ſame Denomination, are $\frac{21\times16}{56}$ and $\frac{16}{56}$ conſequently $\frac{21\times16}{56}$ is the $\left\{\begin{matrix}\text{Sum}\\ \text{Difference}\end{matrix}\right\}$ of the Fractions; *that is*, the Sum is $\frac{37}{56}$ the Difference $\frac{5}{56}$, *which was required.*

Multiplication of Fractions Demonſtrated.

FOR finding the Product of any two Fractions, this is the *Rule.*

Multiply the Numerators together, for a new Numerator, and the Denominators together for a new Denominator; the Fraction thus produced is the Product.

Exam. Suppoſe $\frac{3}{4}$ was given to be Multiplied by $\frac{2}{3}$, the Product is $\frac{2\times3}{3\times4}=\frac{6}{12}=\frac{1}{2}$.

The reaſon of this is evident, for by the 5th Conſequent, I conſider theſe Fractions as the Quotes of their Numerators, divided by their Denominators, and ſo if I Multiply $\frac{3}{4}$ by 2, it gives $\frac{2\times3}{4}$, for to double any Quote is to double the Dividend; but now, ſince I have Multiplied by 2, when I ſhould have Multiplied by $\frac{1}{3}$ of 2, therefore

fore $\frac{1}{3}$ of this Product is the truth, which I effect by tripling the Divisor 4, therefore $\frac{2\times3}{3\times4}$ ($=\frac{1}{2}$) is the product of $\frac{2}{3}$ by $\frac{3}{4}$.

Hence the Product of two Fractions is evidently less than either of them.

And hence, also, the reducing of Compound Fractions to Simple ones is very clear. For to take the $\frac{2}{3}$ of $\frac{3}{4}$ is no more than to Multiply those two Fractions together.

Division of Fractions Demonstrated.

FOR working of Division the *Rule is.*
Multiply the Denominator of the Divisor, into the Numerator of the Dividend for a new Numerator; and the Numerator of the Divisor, into the Denominator of the Dividend for a new Denominator, the Fraction thus formed is the Quote.

Suppose $\frac{2}{3}$ to be divided by $\frac{3}{4}$

$\frac{3}{4}$) $\frac{2}{3}$ ($\frac{4\times2}{3\times3} = \frac{8}{9}$ *Quotient.*

Here, as before, I take the Fractions as Quotients; ſo that if the Example had been, how many $\frac{1}{4}$ is in $\frac{2}{3}$? The Anſwer would be $\frac{4\times2}{3}$ ſo that is only Quadrupling the Numerator, there being 4 times as many Quarters as there are Units; but ſince my Diviſor is $\frac{3}{4}$, 'tis evident the former Quote is 3 times too much, wherefore I take $\frac{1}{3}$ of it by tripling the Diviſor, and then it ſtands as above.

Decimal Fractions Demonſtrated.

DEcimal Fractions, (as I have before noted) are only Fractions, whoſe Denominators are an Unit with Cyphers, as $\frac{7}{10}$, $\frac{35}{100}$, $\frac{284}{1000}$, $\frac{36}{10000}$, *&c.* are Decimals, and are conveniently writ without their Denominators, with a point before them thus .7 .135 .284 .0036, *&c.*

So where the places of the Numerator, are not equal to the Cyphers in the Denominator; ſuch defect muſt be ſupply'd by puting Cyphers before the ſignificant Figures

gures of ſuch Numerator, as $\frac{27}{10000}$, $\frac{3}{100000}$, $\frac{437}{1000000}$ are thus written .0027 .00003 .000437.

From this, and the manner of Notation of Decimals, it will plainly appear that .234 is equal to $\frac{2}{10} + \frac{3}{100} + \frac{4}{1000}$. For $\frac{2}{10} = \frac{200}{1000}$ and $\frac{3}{100} = \frac{30}{1000}$ and $\frac{4}{1000} = \frac{4}{1000}$. But $\frac{200}{1000} + \frac{30}{1020} + \frac{4}{1000} = \frac{234}{1000}$ or .234 the Sum *by Conſequent the third.*

So that the firſt place, after the point in Decimals, is the place of Tenths; the ſecond of Hundreds; the third of Thouſands, *&c.* decreaſing in a ſubdecuple Proportion, from Unity towards the Right-hand, as the whole Numbers Increaſe from Unity towards the Left in a decuple Proportion.

The Reaſon of reducing a Vulgar Fraction to a Decimal.

Say, as the Denominator of the given Fraction, to its Numerator; ſo is 10. 100. 1000, *&c. that is*, an Unite with as many Cyphers as I intend my Decimal ſhall have places, to the Numerator of a Decimal equal to it.

Exam. Reduce $\frac{3}{4}$ into a Decimal of two places.

```
4 : 3 : : 100
            3
      -------
     4)300(75
```

So that $.\frac{75}{100}$ or .75 is equal to the proposed Fraction, *by the third Consequent.*

The 5th *Reduction* is here also prov'd, this being the same with that. Only then, we knew not the Name of Decimals for such Fractions as had 10, 100, *&c.* for their Denominators.

Addition and Substraction of Decimals Demonstrated.

PLace Tenths under Tenths, Hundredths under Hundredths, Thousandths under Thousandths, *&c.*

If there be whole Numbers join'd with the Decimals, place Units under Units, Tens under Tens, *&c.* and in the Decimal part place *Tenths* under *Tenths*, *Hundredths* under *Hundredths*, &c. then

add

add or *substract* as if they were whole Numbers.

Example in Addition.

6. 4		6.400
298. 23	*that is*	298. 230
43. 171		43. 171
347.801		347.801

Example in Substraction.

From 5. 46	*that is*	From 5. 46.
Take 2. 9		Take 2. 90
2. 56 *Rem.*		2. 56 *Re.*

Multiplication of Decimals Demonstrated.

MUltiply Integers and Decimals together, as if all were Integers, and then cut off as many Places from the Product towards your Right-hand, as is the Number of Decimal places in both Multiplicand and Multiplior.

Exam. Multiply 32.4 .0023
7.6 .09

1944 Prod. 000207
2268

Prod. 24624

Here 32.4 is $\frac{324}{10}$ and 7.6 is $\frac{76}{10}$ which two Fractions Multiplied by the Rule given, for Multiplication of Vulgar Fractions produceth $\frac{24624}{100}$ or 256.24 the ſame holds in all other.

Diviſion of Decimals Demonſtrated.

Divide the Dividend by the Diviſor in all reſpects, as in whole Numbers, *only obſerve*, that ſo many Decimal Places as are in the Dividend, more than in the Diviſor, ſo many muſt be cut off from the Quotient to the Right-hand for Decimals.

Exam.

Exam. Divide 7.9 by 34.3

```
34.3(7.9000(.230
    686
    ----
    1040
    1029
    ----
     110
```

For $34.3 = \frac{343}{10}$ and $7.9 = \frac{79}{10} = \frac{79000}{10000}$.

$\frac{343}{10}) \frac{79000}{10000} (\frac{790000}{3430000} = .230$ *near.*

The reason of which is evident from Vulgar Fractions.

PART III.

Containing the

Use and Application

OF

ARITHMETICK,

In the Several

OFFICES

OF HER

Majesty's Revenue.

WITH A

Collection of Questions.

By William Alingham, Teacher of the Mathematicks.

LONDON:

Printed in the Year 1705.

IN THE

Treasury and *Exchequer*.

THAT I might make this Piece of Arithmetick more Universal, and immediately Useful, I shall here give a Tast of it in the present Practice of several of her Majesty's Offices of Revenue.

First, in the *Treasury* and *Exchequer*, there is need of being skill'd in Arithmetick, both in whole Numbers and Fractions, for the making of Dividends and Proportions; as also, for the Casting up the Interest of any Sum of Money for any Rate and Time, with several other things of this Nature.

For doing of which, several practical Rules are used different from the common Road.

I shall give an Instance of *two* or *three* that are very Useful and Necessary.

One

One of them is this, *Division* being the most difficult and troublesome of the first four Rules of Arithmetick, especially when the Divisor consists of many Places, 'tis then the best and surest way to make a Table of Divisors, *thus*; Multiply your Divisor by every one of the nine Digits, making a Table of the Products by setting them one under another as followeth: From which Table you may immediately see whether the Divisor can be taken *Once*, *Twice*, *Thrice*, *&c.* in the Dividend. For *Example*, suppose 658794579828754 to be divided by 1748692583647, Here I multiply the Divisor by the 9 Digits, and *Tabulate* them as followeth.

1748692583647	1
3497385167294	2
5246077750941	3
6994770334588	4
8743462918235	5
10492155501882	6
12240848085529	7
13989540669176	8
15738233252823	9

The

The Table thus prepared, place your Divisor and Dividend in the following Order.

```
1748692583647)6587945798287554(376
              5246077750941
              -------------
              1341868047346 5
              1224084808552 9
              -------------
               117783238793 64
               104921555018 82
              -------------
                12861683774 82
              -------------
```

First, Seek how many times the Divisor is contain'd in the first thirteen Figures of the Dividend, which by the preceding Table you'll find thrice, so I set the Product of the Divisor by 3, under the first 13 Figures of the Dividend, and Substract, bringing down to the Remainder, the Figure 5 in the Dividend. Then I seek how oft this Divisor is contain'd in the Remainder, and the Figure brought down, which by the Table of Divisors I find to be 7, wherefore I set down the Product of the Divisor by 7, under the Remainder and Figure brought down, and Substract there from, bringing the other Figure in the Dividend down to the Remainder, and then seeking again as before.

This

This manner of dividing by a Table, is of great and excellent use in large Divisions.

Secondly, In Branching off the Overplus of a Revenue to others, which are Deficient, there is often required several very large Proportions to be made, which may be contracted as followeth.

For Instance, suppose the Sum of 62317 *l.* 10 *s.* be ordered to pay off a proportional Part of the following Deficiencies, the Question is what must be paid upon each Deficiency,

1*st*. 4 *s*. Aid ————————	36356=18=3
1*st*. 3 *s*. Aid ————————	424099=16=0
Poll Tax————————————	60278=14=9
Additional Impositions —	25196=15=6
Births and Burials————	37684=17=3
Tonnage and Poundage—	286015=06=0
Duty on Leather ————	1116=00=9
	870748=08=6

According to the common way of Working this Question, there ought to be 7 different Statings.

For as the whole Deficiency, to the whole Money allotted to pay, so is any particular

ticular Branch of the Deficiency, to a proportional Part to pay that Branch.

But the method I advise to in such Cases, is this, reduce the Shillings, Pence and Farthings, of all the Sums into Decimals, and annex them to the whole Numbers, and to the Money allotted to pay off, add 6. 8. 10 or more Decimals if need require. Then divide this Sum by the whole Deficiency, and Multiply the Quote of each particular Branch of it, the Product is the Money that must pay off such of it.

If 870748 *l.* 425 parts give 62317.5. What shall any one of the Branches ?

Here, according to the preceding Rule, I add 10 Cyphers to the second Term, and then divide by the first, which gives the following Quote.

870748.425) 62317. 50000000000 (.07156774

This Quote .07156774 Multiply'd by each of these particular Branches, will give each of their Proportions.

The

The odd Money in each Branch, reduc'd to Decimals, ſtands thus.

1ſt. 4 s. Aid	36356.9125
1ſt. 3 s. Aid	424099.8
Poll Tax	60278.7375
Additional Impoſitions	25196.775
Births and Burials	37684.8625
Tonnage and Poundage	286015.3
Duty on Leather	1116.0375
	870748.4250

The Queſtion being ſtated and operated according to the preceding Directions, there will come out part of the Overplus Money, that muſt be paid to each Branch; *that is*, Deficient, as is expreſt in the following Table.

1ſt. 4 s. Aid	2601=19=7 $\frac{3}{4}$
1ſt. 3 s. Aid	30351=17=3 $\frac{1}{2}$
Poll Tax	4314=00=3 $\frac{1}{4}$
Additional Impoſitions	1803=05=6 $\frac{1}{4}$
Births and Burials	2697=00=4 $\frac{3}{4}$
Tonnage and Poundage	20469=09=4 $\frac{1}{4}$
Duty on Leather	79=17=5 $\frac{1}{4}$
	62317=09=11

But

But here note, that there is a Deficiency of one Penny to make up the compleat Sum of 623:17:10 which Deficiency is upon the account of the Decimals, that is omitted in the Product of their Multiplication.

I shall conclude this, with giving you a very concise Rule, which I receiv'd from my loving Friend Mr. *Ralph Snow*, Writing Master in *Morefields*.

This Rule supposes first, that all Sums be calculated for 5 *l. per Cent.* and when 'tis so done, 'tis easy to reduce it to any other rate of Interest, *thus*.

For admiting it to be at 5 *l. per Cent. per Ann.* 'tis but adding $\frac{1}{5}$ of the rate at 5 *per Ann.* to it, and it gives it at 6 *l. per Cent. per Ann.* So also, if you add $\frac{2}{5}$, it gives it at 7 *l. per Cent. per Ann.* and *contrary*, if you Substract $\frac{1}{5}$ of the Interest at 5 *l. per Cent. per Ann.* 'twill give it at 4 *l. perCent. per Ann.*&c.

But $\frac{1}{5}$ is .2 and $\frac{2}{5}$ is .4 *&c.* Hence therefore, if the Interest of any Sum of Money for any time be given at 5 *l. per Cent.* 'tis easily reduc'd to any other rate. For *Example*, The Interest of 250 *l.* at 5 *l. per Cent.* for two Years is 25 *l.* what is the Interest of it at 6 *l. per Cent. per Ann.*

Intereſt at 5 *l.* *per Cent.*	25 *l.*
The Fifth————————	.2
This added————————	5.0
To—————————————	25.0

Makes—————————.30.0 the Intereſt of 250 *l.* for two Years at 6 *l.* *per Cent.* *per Ann.*

note ye: rule, note ye: principall be made pence

Hence 'tis eaſy to make this general Rule. *Multiply the given Principal by the Number of Days; the Product divide by* 7300, *the Quote is the Intereſt of ſuch Principal, for the time,* at 5 l. per Cent. per Ann.

	l.	Days	*l.*	*l.*	Days
For	100	365	5	250	130

Therefore $\frac{100}{5}$ x365)250x730x240(=30*l.* *An*

Or $\frac{100\text{x}365}{5}$) 250x730x240(=30 *Anſwer.*

Note, The given Principal muſt be reduced into Pence, which is the reaſon I Multiply by 240.

IN THE

CUSTOM-HOUSE.

ARithmetick is of great Use in most of the distinct Offices in this Palce, and therefore both Clerks, and other Officers, ought to be well vers'd, at least, in the practical Rules herein.

But particularly and principally such as cast up the Accounts the *Land-waiters* take at the Water-side, which is of all Goods Exported and Imported. From which *Inventory*, or *Account* thus taken, they Cast up at the settled Rate, what the Custom of any Quantity or Parcel of Goods will amount to, making such Allowances for *Tret* and *Tare*, as is Customary and Usual for particular Commodities.

Some of the practical Rules as are now used at the *Custom-House*, for Casting up the *Tare* of several Commodities, are such as follow.

First ſor, deducting of Tare, *Multiply the Number of C. weight Groſs, by the pounds* Tare *to be allow'd* per C. *weight, the Product divide by* 112, *the Quote gives the whole* Tare, *which ſubſtracted from the Groſs leaves the Net weight*, for which Cuſtom is to be paid.

Exam. 32 C. weight of Raiſons, the *Tare* is 14 *l. per* C. weight; how many C. Net.

32
14
128
32
448

$$\begin{array}{r} 32 \\ 14 \\ \hline 112)448(4 \end{array}$$ C. weight *Tare.*

Notes, 1*ſt*. If there had been 32 C. weight $\frac{1}{2}$, the *Tare* would have been 7 ℔. more; *that is*, the half of 14. If $\frac{1}{4}$ then a quarter of 14.

2*dly*. If the *Tare* had been at 14 ℔. $\frac{1}{2}$, or 14 ℔. $\frac{1}{4}$ *per* C. weight, then you muſt have taken $\frac{1}{2}$ or $\frac{1}{4}$ of 32, and added to the former *Tare.*

3*dly*. If the *Tare* be 7 ℔. *per* C. divide the the Groſs weight by 16, and the Quote gives the C. weight *Tare*; the reaſon is, becauſe 7 is $\frac{1}{16}$ of 112.

4*thly*. If the *Tare* be at 8 ℔. *per* C. weight, divide by 14, the Quote gives the C. weight *Tare*, for 8 is $\frac{1}{14}$ of 112.

5*thly*.

5thly. If the *Tare* be at 14 ℔. *per* C. weight, divide by 8, and the Quote gives the like, for 14 is $\frac{1}{8}$ of 112.

6thly. If the *Tare* be at 16 ℔. *per* C. weight, divide by 7, and the Quote gives the C. weight *Tare*, for 16 is $\frac{1}{7}$ of 112.

More *Examples* of this Nature might be given, but these are sufficient to give you a Tast of the Business.

I shall next mention something of the *Land-waiter*'s Business, and the manner of their *Entries* at the Keys.

The *Land-waiters* having receiv'd their *Warrants*, for the taking an Account of such and such particular Commodities as are to be Exported and Imported, they at convenient times attend the Ship from which they are taken out, or into which they are carried, and write down the Commodity, with the number, Weight, or Measure of it; also, the allowance for *Tare*, as is Customary and Usual, with the *Mark* and *Number* of it, after which they give such account into the proper Office in the *Custom-House*, for casting up the Custom that is due upon it.

This is the principal Business of this Officer, and therefore he who endeavours the getting of such Employment, ought to have some competent Knowledge in Arithme-

tick. I shall now proceed to show you the Practical Rules for Gauging of Oil and Wine Casks, and Measuring of Timber.

The General Rule used upon the Keys for Gauging all sorts of Wine or Oil Casks, is thus,

T*Ake the Diameter of Cask at Bung and Head within the Wood, as also the length of the Cask within the Heads, and set them all three down severally.*

By these Diameters find out the *Area* of the Circles to them belonging, *Thus,*

Multiply the Diameter by it self, and the Product thereof by 11. *The Quote divide by* 14, *it gives the Area of that Circle.*

Take the Area of the Bung and Head Circles, being got after this manner; Multiply the Bung Area by 2, *and divide by* 3, *it gives* $\frac{2}{3}$ *of the Area of the Bung Diameter; to this add* $\frac{1}{3}$ *of the Area of the Head Diameter, found as above directed.*

The Sum of these is a mean Area of the Cask; this mean Area multiplied by the length of the Cask, and the Product divided by 231, (the Cubick Inches contained in a Gallon of Wine or Oil) will give the Number of Gallons the Cask contains.

For

For *Example*, Let the Dimension of a Cask be as followeth.

Bung Diameter 36 Inch.
Head Diameter 30 Inch.
Length ——— 50 Inch.

```
36 }
36 } B Diameter.
---
216
108
----
1296
  11
-----
14)14256(1018 Area B. Diameter.
           2
      ----
      2036
         3
      ----
      678 ⅔, two thirds of it.
      ----
```

$$\left.\begin{array}{r}30\\30\end{array}\right\} H.\ \text{Diameter.}$$

$$\begin{array}{l}
900\\
\underline{\ \ 11}\\
14)9900(707\ \text{Area } H.\ \text{Diameter.}\\
\qquad\qquad 235.\tfrac{2}{3}\ \text{one third } H.\ D.\\
\qquad\qquad \underline{678\tfrac{2}{3}\ \text{two thirds } B.\ D.}\\
\qquad\qquad 914\tfrac{1}{3}\\
\qquad\qquad \underline{\quad\ 50}\\
\qquad\qquad 45716\tfrac{2}{3}\ \text{contains in Cub. Inc.}\\
\\
231)45716(197\ \text{Gallons.}\\
\qquad \underline{2261}\\
\qquad \underline{\ 1826}\\
\qquad \underline{\ \ 209}
\end{array}$$

This Remainder of 209 multiplied by 4, and divided by 231 will give 3 Quarts, and something better, so that the content of this Cask is 197 Gallons 3 Quarts, *near*.

Note,

Note, I reject the Remainder, when I divide by 14 as insignificant, it being near enough in common Practice.

But if you would Work it to a Nicety, or if the Dimensions of the Diameters, or length, have parts of Inches in them, reduce them to Decimals, and that will make the Work short and easy.

I shall end this of Gauging a Cask, with showing you the *Custom-House* Rule, for casting up the Net weight of Oil.

But first 'tis to be noted, that 7 ℔. and $\frac{1}{2}$ of Oil is a Gallon; and for Oil in uncertain Casks there is to be allowed 18 ℔. for every C. for *Tare*.

And therfore *substract the Tare allow'd from the Gross C. and by the Remainder multiply the Gross weight, double the Product, and it brings it into half Pounds, which divide by* 15, (*the half Pounds contain'd in a Gallon*) *and the Quote will give the Net contents of the Vessel.*

Exam. Suppose the Gross weight of a Vessel of Oil be 30 C. $\frac{1}{4}$.

From

From 112
Take 18

94
Multity by 30

2820 Pounds Nett.

Then the *Tare* of $\frac{1}{4}$ is 4 lb. $\frac{1}{2}$, which taken from 28 leaves 23 $\frac{1}{2}$, this added to 2820 lb. gives 2843 $\frac{1}{2}$, which doubled makes 5687 half Pounds, and then divided by 15, gives 379 $\frac{2}{15}$ the Number of Gallons, which is the Nett content of the Veſſel.

To find the Tonnage of a Ship; that is, *to Meaſure it.*

Rule, Meaſure the Length of Keel, alſo the Length of the Midſhip Beam withinſide, alſo the Depth of the Hold; *that is*, from the Plank below the Kelſey, to the under part of the Upper-Deck Plank; then multiply theſe 3 Products together continually one into another, and divide the laſt Product by 94, the Quote will give her Tonnage.

Exam. Suppoſe the Length of the Keel of a Ship be 72 Foot; the Breadth or Length

Length of the Midſhip Beam 24 Foot, and the Depth 15 Foot, What's her Tonnage?

Multiply 72 by 24, it gives 1728, this Product multiply by 15, the Depth it gives 25920, this Product divide by 94, it gives 275 $\frac{2}{3}$, *near*, which is the Tonnage, or Number of Tuns; *that is*, the Ships Burthen.

The general Rule uſed at the Cuſtom-Houſe *for Meaſuring of Timber.*

The Timber imported here is none but Square; *that is*, four ſided, except Maſts for Ships, and their Duty is ſo much a piece.

I ſhall therefore only give you the Rule for Meaſuring of four-ſided Timber, whether the ſame be truly Square, or of unequal Sides.

Rule, Take the Inches on the one ſide, and alſo on the other, (if it be not truly Square) juſt in the middle of the piece, and multiply the one by the other, and that Product again by the Length, and it gives the content.

Exam. Suppoſe one ſide of a piece of Timber be 1 Foot 2 Inches, the other 1 Foot 4 Inches, the Length 20 Foot, What's the Content?

See

8
20
160
12
13-4
133
12
11-1
1
20
20
11
31-1-4

See the Operation.

F.	In.	
1.	4.	
1.	2.	
1.	4	
	2.	8
1.	6.	8
	20	Length.
31	1	4 Solid content.

This is a very short practical way, for first I multiply 1 Foot 4 Inches, by 1 Foot 2 Inches, it gives 1 Foot 6 Inches 8 parts; this I multiply by 20 Foot the Length, it gives 31 Foot 1 Inch 4 parts, the Content of such a piece of Timber.

The Inches and Parts above the 31 Foot, may be neglected as inconsiderable.

Note, This way of taking the Dimensions of the Thickness and Breadth of the Sides, in the middle of the piece is false, if the piece be Tapering, as I have shown in my *Epitome of Geometry*, where I have prov'd that those Dimensions ought to be taken, in this Case, at near $\frac{1}{3}$ from the greater end.

IN

IN THE

EXCISE-OFFICE.

THE Knowledge of the Practice of Arithmetick is of great Use, particularly *Addition*, *Substraction*, *Multiplication* and *Division*, in whole Numbers and Fractions, both *Vulgar* and *Decimal*; as likewise, the *Rule of Three* and *Practice*.

With the assistance of these a Person may be Capable of Officiating a Clerk's place, in the *Accomptants* or *Receivers* Office.

Moreover, before any of those that design themselves for *Officers*, or *Gaugers* in the *Excise*, can have an Order for there Practical Instruction, they must be Examined either by *Examinants* appointed by the *Commissioners* for that purpose, (or else by a *Surveyor*) whether they Understand, or can Work the first four Rules of Arithmetick; as also, the Rule of Three and Practice, and upon Certificate brought from the *Examinant*, or *Surveyor* to the *Commissioners*, that they

they are qualified with the aforesaid Rules; then if the *Commissioners* think fit, they give them an Order to a *Surveyor*, for their further Instruction in the practical way of Gauging, by taking their Walks with the *Surveyor*, and seeing the Officer take the Dimensions both of Backs and Coolers; as also, the method of setting down those Dimensions, and casting them up, and this Instruction is to be given them both for the *Brewry* and *Distillery*.

This the Person pursues, till the *Surveyor* is sensible that he is perfect of the same; and then he writes a Certificate, that after so long Instructions from him, he finds you fitly qualify'd for a Gauger's place when an Opportunity presents, and the *Commissioners* think fit to bestow it upon you.

Some of the things you are instructed in by the *Surveyor*, are such as these.

Exam. 1. If a Cooler or Back hold upon 6 Inches, 48 Gallons, 6 Tenths, what doth it contain upon one Inch.

Take the $\frac{1}{6}$ part of 48 Gallons 6

8. 1 Upon one Inch.

8 gallons $\frac{1}{10}$, upon one Inch

This

This doubled, is what it holds upon two Inches; tripled, is what it holds upon three Inches.

After this manner may you find when a Vessel holds any Number of Gallons, upon any Number of Inches Deep, what it holds upon one Inch deep; and if you know what it holds upon one Inch deep, you may know what it holds upon any Number of Inches deep.

Exam. 2. Suppose a Round, or Square Tun, holds 165 Gallons, upon 7 $\frac{1}{2}$ Inches deep; what doth it hold upon one Inch deep.

Reduce the Inches into half Inches, it gives 15, by this 15 divide 165, the Quote is 11, which is what it holds upon half an Inch deep, this doubled gives (22) what it holds upon one Inch deep, tripled, is what it holds upon an Inch and half deep.

Again, suppose I would turn Gallons of Ale or Beer, to Gallons of Wine, and contrary; *that is*, to turn Wine Gallons to Beer or Ale Gallons.

Rule, *Multiply the Ale Gallons given by 282, and divide the Product by 231, the Quote is Wine Gallons.*

Example 1. In 72 Ale Gallons, how many Wine Gallons? *Answer*, 87 $\frac{207}{231}$ Gallons.

See the Work.

```
 282
  72
----
 564
1974
-----
20304
```

```
231)20304(87 Gallons.
    -----
    1824
    ----
     207
    ----
```

But if you would turn Wine Gallons to Ale Gallons; *then multiply the given Wine Gallons by* 231, *and divide the Product by* 282, *the Quote is Ale Gallons.*

Exam. In 100 Wine Gallons, how many Ale Gallons? *Answ.* 81 $\frac{258}{282}$.

See the Work.

```
     100
     231
     ---
282)23100(81 258/282 Gallons.
    -----
     540
     ---
     258
```

As

As to the Gauging, or finding the quantity of any kind of Tun or Veſſel, any Number of Inches deep, you may find it amply taught both *Arithmetically* and *Inſtrumentally*, by a ſliding Rule in a Book called *Stereometry*, or the Art of *Gauging*, newly ſet forth by *Thom. Everard*, Eſq; late *Commiſſioner* of the *Exciſe*; in which Book he has fully ſhown the whole Buſineſs of Gauging, both by Arithmetick, and a ſliding Rule of his own Contrivance, which method is now generally practiſed by the Gaugers in the *Exciſe*, and which is directed by the *Commiſſioners* to be ſtudied and learn'd by thoſe who would be Officers therein, and therefore I ſhall deſiſt ſaying any more of this Office; but refer them to the ſaid Book, which is to be had by *R. Clavel* in St. *Paul's Church-yard*, and *C. Huſſey* in *Little Britain*.

Of things relating to the Computing of Soldiers and Seamens Wages.

IN the Pay-Offices of the Army, the first four Rules of Arithmetick; as alſo, the Rule of Three, Practice and Fractions, are highly Neceſſary, for computing the Amount of any Number of Men at ſo much *per* Man; but before I give you the Uſe and Practice of Arithmetick in theſe kind of Accounts, it will be requiſite to give an Explanation of ſome Terms relating to the Eſtabliſhment of a Regiment.

The *Eſtabliſhment* of a Regiment, is the aſcertaining the Pay *per* day, of all the Officers and Soldiers in a Regiment.

Subſiſtance-Money, is the Money paid preſent to each Officer and Soldier in a Regiment, and is to ſupply their preſent Exigencies and Occaſions.

Regu-

Regulation of *Subsistance*, is what is thought necessary, for the present, upon some Extraordinary Occasion; and therefore may be a greater or lesser part of the Full Pay *per* Day, as necessity requires, and so is renew'd from time to time.

Off-Reckonings, is what is deducted out of each Man's Pay *per* Day, for Cloaths.

Poundage, is an Allowance to the Pay-Master-General of 12 *d. per* Pound, out of all Moneys he pays for the Use of the Army.

Royal Hospital, is a Deduction of one Days Pay in a Year, from both Officers and Soldiers, and is stopt by the *Pay-Master-General*.

An *Agent* of a *Regiment*, is an Officer put in by the Government, and by Virtue of a Letter of Attorney is to transact all Matters as relate to the said Regiment. And according to the *Establishment*, *Muster-Rolls*, &c. to Account with the *Pay-Master-General* of her Majesty's Forces, for all Money issued out of the Pay-Office, whether on account of *Pay*, *Subsistance*, *Off-Reckonings*, *Contingences*, &c. *Receipts* or *Acquittances* to give for the same, or any part thereof; and according to the Articles or Tenure of the said Account, shall truly destribute to each Captain, his or their just and equal Proportion for *himself*, *Officers* and *Soldiers*, both as to Creditor and Debtor

part of his Account, and that as often, if requir'd, or needful, as he shall so receive or account with the said *Pay-Master-General.*

Agency, is an Allowance of 2 *d. per* Pound, out of all the Money receiv'd by the *Agent* from the *Pay-Master-General* over and above which, he has the payment of one Man in a Company.

Respits, are those who are not at the *General Muster* or *Call*, of the *Rolls*, and so are prick'd two Months by the *Commissary*, which Deficiency falls to the *Queen*, except one Days Pay, which goes to the *Commissary.*

Contingencies, are accidental Charges that may happen to an Army in a *March*, or in *Garrison.*

Suppose the Establishment of a Regiment of HORSE, as followeth.

Staff and Field-Officers.

	l.	s.	d.
Colonel as Colonel, *per Diem*	0	12	0
Lieutenant-Colonel, as Lieutenant Colonel	0	8	0
Major without a Troop	1	0	0
Chaplain	0	6	8
Adjutant	0	5	0
Chirurgeon	0	6	0
Kettle Drum	0	3	0
Sum	3	00	8

One TROOP.

	l.	s.	d.
Captain 10 *s.* and 2 Horses, 2 *s.* each	0	14	0
Lieutenant 6 *s.* and 2 Horses	0	10	0
Cornet 5 *s.* and 2 Horses	0	9	0
Quarter-Master, 4 *s.* and 1 Horse	0	6	0
Two Trumpeters, 2 *s.* 8 *d.* each	0	5	4
Three Corporals, 3 *s.* each	0	9	0
59 Private Men, 2 *s.* 6 *d.* each	7	7	6
	10	00	10

Regulation of Subsistance.

	l.	s.	d.
Colonel and Captain	0	13	0
Lieutenant-Colonel and Captain	0	11	0
Major	0	10	0
4 Captains, each 7 *s.*	1	8	0
6 Lieutenants, each 5 *s.*	1	10	0
6 Cornets, each 4 *s.* 6 *d.*	1	7	0
6 Quarter-Masters, each 3 *s.*	0	18	0
Chaplain	0	5	0
Adjutant	0	4	0
Chirurgeon	0	4	0
Corporals 18, at 2 *s.* 6 *d.*	2	5	0
Kettle Drummer	0	2	6
Trumpeters 12, each 2 *s.*	1	4	0
354 Men, 2 *s.* each	35	8	0
	46	9	6

The Pay, of 5 Troops more to compleat this Regiment at the same Rates and Numbers, as in the Troop above, comes to 50 *l.* 4 *s.* 2 *d.* so that the Total Charge of this Regiment for one Day is 63 *l.* 5 *s.* 8 *d.*

The

The manner of Computing the Off-reckonings.

By the full *Off-reckonings* of 18 *Corporals*, and 354 Men, in all 372 Men, at 6 *d. per Diem*, each from the first of *April*, 1700, to the last of *December*, 1703, both days included, is 1371 days, which at 9 *l*. 6 *s*. *per* day, comes to 12750 *l*. 6 *s*.

From this is to be Deducted.

	l.	*s.*	*d.*
Poundage of full pay (being 64368 *l*. 9 *s*. ————	3218	8	5 $\frac{1}{2}$
Royal Hospital ————	176	7	0 $\frac{1}{2}$
Agency ————	536	8	1
In all	3931	3	7

This 3931 *l*. 3 *s*. 7 *d*. substracted from from 12750 *l*. 6 *s*. leaves 8819 *l*. 2 *s*. 5 *d*. the *Nett Off-reckonings*, which are thus to be destributed.

The Officers for their Servants Off-reckonings, *is thus.*

The *Colonel* ——	6 Servants.
5 *Captains* ——	15
6 *Lieutenants* —	12
6 *Cornets* ——	12
6 *Quarter Masters*	6
In all	51

So that there is 51 Servants, which at 6 *d. per Diem, per* Man, for 1371 days comes to 1748 *l.* 0 *s.* 6 *d.*

From this is to be deducted.

	l.	*s.*	*d.*
Poundage of full pay (being 8740 *l.* 2 *s.* 6 *d.* ——	437	0	0 ½
Royal Hospital ——	23	18	11
Agency ——	72	16	8 ¼
In all	533	15	7 ¾

This 533 *l.* 15 *s.* 7 *d.* ¾ substracted from 1748 *l.* 0 *s.* 6 *d.* leaves 1214 *l.* 4 *s.* 10 *d.* ¼ which *Remains* being taken from the *Nett*

Off-

Off-reckonings before found, *viz.* 8819 *l.* 2 *s.* 5 *d.* leaves 7604 *l.* 17 *s.* 6 *d.* ¼.

Note, That *Poundage* and *Royal Hospital* is stopt by the *Pay-Master-General*; and the *Agency* by the *Agent*.

Colonels Account.

Dr.

	l.	*s.*	*d.*
To *Poundage* of his full pay, being 1968 *l.* 4 *s.*	98	8	2 ½
To the *Royal Hospital*	5	7	9 ½
To *Agency*	16	8	0 ¼
To 1514 days *Subsistance*, at 13 *s. per Diem.*	984	2	0
To *Arrears* paid	76	13	0
To account of his Servants *Off-reckonings*	152	17	6
To *Ballance*	792	2	5 ¾
	2125	19	0

Captains Account.

Dr.

	l.	*s.*	*d.*
To *Poundage*	58	18	2 ½
To *Royal Hospital*	3	4	6
To *Agency*	9	16	4 ½
To 413 days *Subsistance* at 12 *s. per* Day, according to *Regulation*	247	16	0
To 683 days *Subsistance* at 13 *s.* 6 *d. per Diem.* according to *Regulation*	461	0	6
To account of Servants *Off-reckonings*	47	3	0
To *Ballance*	350	5	5
	1178	4	0

Colo

Colonels Account.

Cr.

	l.	s.	d.
By 1514 days Pay, as Colonel and Captain, from the 19th of *January*, 1693. to the 12th of *March*, 1697. at 1 *l.* 6 *s. per Diem.*	1968	4	0
By the *Nett Off-reckonings* of 6 Servants for the above mentioned time.	157	15	0
	2125	19	0

Captains Account.

Cr.

	l.	s.
By his Pay, as Captain, and three Servants, from the first of *May* 1694. to the last of *April* 1697. both days included, being 1096 days, at 1 *l.* 1 *s.* 6 *d. per Diem.*	1178	4

Cornet

Cornets Account.

Dr.

	l.	s.	d.
To *Poundage* ——	25	11	8 ½
To *Royal Hospital* ——	1	8	0
To *Agency* ——	4	5	1 ½
To 416 days *Subsistance*, at 7 s. 6 d. *per Diem*. ——	156	0	0
To account of *Subsistance* more ——	231	15	0
To account of *Off-reckonings*	37	12	6
To *Ballance* ——	55	1	8
	511	14	0

The Troops Account.

Dr.

	l.	s.	d.
To account of *Subsistance* ——	1356	14	6
To Debts in Quarters ——	437	6	9
To *Provisions* in *Transportation*	57	16	7
To *Ballance* being due to the *Troop* ——	228	12	2
	2080	10	0

Cornets Account.

Cr.

By his Pay, as Cornet, and two Servants from the 5th of *July* 1694. to the 4th of *July* 1696. both included, being 731 days, at 14 *s. per Diem*, according to the *Establishment*.	*l.*	*s.*	*d.*
	511	14	0

The Troops Account.

Cr.

By the *Subsistance* of 1 *Kettle Drum* at 2 *s.* 6 *d.* 2 *Trumpets* each 2 *s.* 3 *Corporals* each 2 *s.* 6 *d.* and 50 private Men each 2 *s.* from the first of *April* 1696. to the last of *March* 1697. being 365 days. at 5 *l.* 14 *s. per Diem.*	*l.*	*s.*	*d.*
	2080	10	0

This

This little Abstract will, I hope, give some light into the nature of these Accounts, for after this manner are the Accounts of a *Regiment* and *Troop*, and of each particular Officer stated and kept by the *Agent*.

I shall conclude this Account with giving you the *practical Rules*, for casting up the *Poundage*, *Royal Hospital*, and *Agency* of any Sum of Money.

What's the *Poundage*, *Royal Hospital*, and *Agency* of 354 Men, at 2 *s.* 6 *d. per* day, for 186 days?

8)354(44 *l.* 5 *s. per* day.

2

Then, What comes 186 days to, at 44 *l.* 5 *s. per* day?

186 days at 44 *l.* 5 *s.*
44

744
744

8184
46.10

8230.10

So that the Pay of 354 Men for 186 days, at 2 *s.* 6 *d. per* day, amounts to 8230 *l.* 10 *s.*

The *Poundage* of which is thus gotten; *Consider*, that every Pound pays a Shilling, whence 'tis so many Shillings as there are Pounds, and therefore divide any number of Pounds by 20, and the Quote is the *Poundage*; but dividing by 20 is practically performed, by cutting off the last Figure next the Right-hand, and halving the Remainder.

For *Example*, What's the *Poundage* of of 8230 *l.* 10 *d.* at 12 *d. per* Pound.

823 | 0

411.10.0 *the Poundage.*

The *Poundage* of any oddShillings is computed, by saying, If 20 *s.* give 12 *d.* what shall any other number of Shillings give, according to which Rule the *Poundage* of 10 *s.* will be 6 *d.* and 5 *s.* will be 3 *d. &c.*

Next for computiting the **Royal Hospital** Money, which is one Days Pay of each Man in a Year; *'tis done thus.*

Exam.

Exam. What Money is due to the *Royal Hospital*, from 354 Men for 186 days, at 2 *s.* 6 *d. per* day?

354 Men at 2 *s.* 6 *d. per* Man.
2

708
177

88|5

44·5

From this Calculation 'tis evident, that if the time were 365 days, the Money due to the *Royal Hospital* for 354 Men at 2 *s.* 6 *d. per* Man, would be 44 *l.* 5 *s.* But since the number of days are less than 365. *Make this Proportion.*

If

If 365 days give 44 *l.* 5 *s.* what will 186 days give,

365)8230.500(22.549	44
	744
930	744
2005	8184
	46.10
1800	8230 : 10
3400	
115	

In multiplying the third number by the second, I do it practically; *that is,* multiply the days by the Pounds, and for the Shillings above the Pounds, I take aliquot Parts, then in dividing the Product by 365, I turn the Shillings into Decimals, and add so many Cyphers more to such Decimal, as will make my Quote come out to less than a Farthing; *that is,* you must never have less than 3 Decimal places in the Quote, thus proceeding, 'tis evident, from the foregoing Operation, that the *Royal Hospital* Money of 354 Men for 186 days, at 2 *s.* 6 *d. per* day, is 22 *l.* 11 *s. near, that is,* to less than one Farthing.

Note 1. If the time be more than 365 days, the like Proportion must be made; unless it happen to be just 2, 3 or more Years, for then 'tis but *Doubling*, *Tripling*, *&c.* the Sum for one Year.

Note 2. The Officers, tho' they have the same number of days, yet, because, their pay *per* day is different, there must be a Proportion made for each Officer.

For *Example*, What's the *Royal Hospital* Money for 186 days.

$$\text{Of a}\left\{\begin{array}{l}\textit{Colonel}\\ \textit{Major}\\ \textit{Quarter-Master}\end{array}\right\}\text{whose Pay } \textit{per} \text{ day is}\left\{\begin{array}{c}l.\ \ s.\\ 1:6\\ 1:0\\ 0:6\end{array}\right.$$

Say, by the Rule *of* Three,

$$\text{As } 365 \text{ to}\left\{\begin{array}{c}l.\ \ s.\\ 1:6\\ 1:0\\ 0:6\end{array}\right\}\text{So is } 186 \text{ to}\left\{\begin{array}{c}s.\ \ d.\\ 13.\ 3\\ 10.\ 2\tfrac{1}{4}\\ 3.\ 0\tfrac{3}{4}\end{array}\right.$$

So that by this Proportion it appears, that the *Colonel* must pay 13 *s.* 3 *d.* for 186 days, the *Major* 10 *s.* 2 *d.* $\frac{1}{4}$, and the *Quarter-Master* 3 *s.* 0 *d.* $\frac{3}{4}$.

Lastly, To compute **Agency**, which is 2 *d. per* Pound. So that every 6 *l.* gives 1 *s.*

to

to the *Agent*, and therefore divide any number of Pounds by 6, it gives the number of Shillings the *Agency* amounts to.

For *Example*, What's the *Agency* of 8230*l.* 10 *s.*

6(8230)1371. $\frac{4}{6}$

that is 1371 *s.* 9 *d.*

Or 68*l.* 11 *s.* 9 *d.* the *Agency.*

The *Agency* of 8230 *l.* comes to 1371 *s.* and $\frac{4}{6}$ of a Shilling, which is 8 *d.* and the *Agency* of 10 *s.* is a Penny; *that is*, 1371 *s.* 9 *d.* or 68 *l.* 11 *s.* 9 *d.* the *Agency* of the whole Sum.

Note, The *Royal Hospital* in small Sums is nearly $\frac{1}{3}$ of the *Agency*, as in the preceding Case, which is a large Sum, it differs not 20 *s.* and therefore in small Cases, as in the single pay of Officers, you may take $\frac{1}{3}$ of *Agency* for *Royal Hospital.*

Questions relating to the computing of Soldiers *and* Seamens *Wages; Also Computation of Subsistance upon several extraordinary Occasions.*

By Multiplication.

IF the pay of one *Soldier* be 8 *d. per* day, what's that for 40000 Men? *Answer*, 320000 *d.* or 1333 *l.* 6 *s.* 8 *d.*

If the pay of one *Seaman* be 23 *s.* for one Month, or 28 Days, how much is that *per* Month for 36000? *Answer*, 828000 *s.* or 41400 *l.*

Of what number doth that Army consist off which hath 856 Men in *Rank*, and 54 in *File*? *Answer*, 46224.

By Division.

Suppose there be ordered for a *Battery* of 38 pieces of *Ordinance*, 1824 pound of Powder, how much is that for each Piece? *Answer*, 48 *pound.*

Let 117000 *l.* be ordered for an Expedition of 180 days, what's the expence of one day? *Answer*, 650 *l.*

Ad-

Admit there is ordered for the Subsistance of 1265 Men, 4832 *l.* 10 *s.* what is that *per* Man? *Answer*, 3 *l.* 16 *s.* 4 *d.* $\frac{1}{4}$ *near.*

Suppose a *Battery* of 4 *Mortars* was erected before a Town, from the first was discharged 2 Bombs each hour, from the second 3 Bombs, from the third 4, and from the fourth 5. 'Tis demanded in how many hours they will all discharge 658 Bombs? *Answer*, 47 *Hours.*

By Reduction.

Admit, there is ordered for the Subsistance of a Company, consisting of 60 Men, 150 *l* the Question is how many days it will serve them, and what each Man must have of it according to the following Allowance.

A *Captain* 36 pence
A *Lieutenant* 24 pence
An *Ensign* 20 pence
A *Serjeant* 12 pence
A *Corporal* 8 pence
A *private Soldier* 6 pence
} *per* Day.

Divide the Pence in 150 l. *by the Sum of all those wages* per *day, reduced into Pence, the Quote gives the number of days it will serve them; if then you Multiply this number of days by*

 each

each Man's pay per *day, 'twill give you the Money each Person must receive,*

Proceed thus, and you will find 150 *l.* will serve the foregoing Company of Men 83 days, and that the *Captain* will receive for his share 12 *l.* 9 *s.* the *Lieutenant* 8 *l.* 6 *s.* *Ensign* 6 *l.* 18 *s.* 4 *d.* *Serjeant* 4 *l.* 3 *s.* *Corporal* 2 *l.* 15 *s.* 4 *d.* and each *private Man* 2 *l.* 1 *s.* 6 *d.* beside 1 *l.* 5 *s.* 10 *d.* left, which will not give each of them one days pay more.

Suppose, for a *Battery* of 4 pieces of *Ordinance*, there is appointed 12 C. weight of Powder, each piece carries at a Shot *as followeth.*

First 14 pound,
Second 12 pound,
Third 8 pound,
Fourth 6 pound.

How many times will the said Powder discharge these Pieces, and what must be allowed to each Piece?

This is done just after the same manner as the former, and the number of times 12 C. *weight will discharge the said Pieces is* 33, *and the first spends* 462 ℔. *the second* 396 ℔. *the third* 264 *l. the fourth* 198 ℔. *beside* 24 ℔. *that is left, which will not make another Round.*

By

By the Rule of Three.

Let thePay of 890 Men, for one, day be 36 *l.* 17 *s* 3 *d.* what is that for 61 days? *As* 890: 36 *l.* 17 *s.* 3 *d*:: 61: 2 *l.* 10 *s.* 6 *d.* ¼ *near, Anſwer.*

Suppoſe 3515 *l.* 10 *s* be ſufficient to pay a *Garriſon* of 1250 Men a certain time, but there is occaſion to reinforce the ſaid *Garriſon* to 3000; how much Money muſt be ordered on ſuch anOccaſion? *Say, as* 1250: 3515 *l.* 5 *s*:: 3000: 8437 *l.* 4 *s. the Anſwer.*

Admit, a *Garriſon* has 6200 Men in it, out of which a *Detachment* is made of 2126 Men, the Subſiſtance for it at firſt was 966 *l.* 13 *s.* what ought it to be now? *Say, as* 6200: 966. 13:: 4074: 635 *l.* 3 *s.* 8 *d. Anſwer.*

The Yearly pay of 10600 Men, is 182500 *l.* 17 *s.* but Money falling ſhort there can be allow'd but 110156 *l.* 14 *s.* how many of theſe muſt be disbanded to make the ſaid Allowance ſerve? *Say, as* 182500 *l.* 17 *s.* : 10600:: 72344 *l.* 3 *s.* 4202 *Men, the Anſwer near.*

If the Cloathing of a Regiment, conſiſting of 1150 Men coſt 4962 *l.* 12 *s.* what is that for one Man? *Say, as* 1150: 4962 *l.* 12 *s*:: 1: 4 *l.* 6 *s.* 3 *d.* ¼ *near.*

Suppose part of a Regiment are ordered on an Expedition, the number of which, with their Subsistance, being as followeth.

One *Captain* at 7 *s.* 9 *d. per* day.
A *Lieutenant* at 6 *s.* 4 *d. per* day.
An *Ensign* at 4 *s.* 7 *d. per* day.
2 *Serjeants* at 1 *s.* 4 *d.* each *per* day.
370 *Soldiers* at 5 *d.* each *per* day.

How much Money will suffice these Men for 270 days? *As* 1 : *to the Sum of all their pays* per *day* :: 270 : 2369 *l.* 5 *s. the Answer.*

A *Soldier* receives for 3 Months 2 Days pay 6 *l.* 15 *s.* what comes his pay to for a Year? Say, *as* 86 : 6 *l.* 15 *s* :: 365 : 28 *l.* 12 *s.* 11 *d.* $\frac{1}{3}$ *near, Answer.*

A *Commissary* of the *Artillery* hath agreed to give for the Carriage of 720 C. $\frac{1}{2}$ of *Ammunition* 270 *l.* 10 *s.* how much must he give for the Carriage of 1260 C. $\frac{3}{4}$? *Say, as* 720 C. $\frac{1}{2}$: 270 *l.* 10 *s* :: 1260$\frac{3}{4}$: 473 *l.* 6 *s.* 7 *d.*

If the common *Composition* for *Gunpowder* be 24 *l.* of *Salt-Peter*, 6 ℔. of *Coal*, and 4 ℔. of *Brimstone*; how much must there be of each of these *Compositions* in 84 C. weight of Powder.

Three *Chief Commanders* took with them a small Body of Men, the first 600, the second 550, and the third 400 Men; they take

take a *Booty* of 1200 *l.* the Division is to be made according to the number of Men each of them had; what must be the share to each Party? *Say, as the Sum of all the Men to the whole Booty, so is each Party, to the share of the Booty. Proceed thus, and you'll find the first had* 900 l. *the second* 825 l. *the third* 600 *l.*

Six Propositions for Embatteling an Army.

Prop. 1. TO place any number of Soldiers (suppose 36000) in such order of *Battle*, that there shall be any number in Rank or File. Suppose 500 in Rank; how many must there be in File.

Divide the whole Number of the Army by the assigned Men in Rank (or File) the Quote (72,) is the number that will be in File (or Rank.)

Prop. 2. To place any number of Soldiers, suppose 65536, in square *Battalia.*

Extract the square Root of 65536, the number of Men proposed, 'twill give 256, the number of Men that must be placed both in Rank or File. *Prop.*

Prop. 3. To place any number of Men, suppose 35912, in double *Battalia*, *that is*, so that the Men in one Rank, may be double to those in one File.

Extract the square Root of 17956, which is half the number of Men proposed, it gives 134 the number that must be placed in File, this doubled, gives 268, the number that must be placed in Rank; these two numbers multiply'd together, will make up the whole Army, if the Work be right.

Prop. 4. To place any number of Soldiees, suppose 12996 in a Battail of the *Grand-Front*, which is in such order, that the Rank may be four times the File.

Extract the square Root of $\frac{1}{4}$, the number of Men, which is 3249, it gives 57, the number that must be placed in File, this 57 multiplied by 4, gives 228 the number to be placed in Rank, and the numbers to be placed in Rank and File multiplied together will give the whole Army.

Prop. 5. Any number of Men with their distance in Rank and File, being propounded, to order them into a square Battail of Ground.

Suppose 25000 Soldiers were to be Martialed in a square Battail of Ground, in such order,

order, that their distance in File should be 8 Foot, and Rank 3 Foot; 'tis required to know how many Men must be in Rank, and how many in File.

Say, as 8 to 3, so is 25000 to 9375 the square Root, of which is 96 *near* the number of Men to be placed in File. Then to find the number of Men to be placed in Rank, divide 25000 by 96, the Quote 260 is the number of Men to be placed in Rank, beside 40 Men over and above.

Prop. 6. Any number of Soldiers pro, pounded to order them in Rank and File-according to the *Ratio* of any two numbers.

Let 48000 be the number of Men to be Martialed in Battail Array in such sort, that the number of Men in File to those in Rank, shall be as 8 to 20.

Say, as 8 to 20, so is 48000 to 120000 the square Root, of which is 346 *near* the number of Men to be placed in Rank, by which divide 48000, it gives 138 the number of Men to be placed in File, beside 252 Men that are left.

Of

Of Measuring.

OF this I shall not say much here, because I have taught the whole method of Measuring *Vulgarly*, *Decimally* and *Practically*, with the Customs used by *Artificers* for Measuring their several Works, in a Book lately published, Entituled, *An Epitome of Geometry*, to which I refer the *Reader*.

And therefore I shall only give some short practical Rules, necessary for casting up the Content of a piece of Work.

Of *Measures* there are three sorts, *viz. Lineal*, call'd (by Artificers) *running Measure*, which respects only length; *Superficial Measure*, which respects *Superficies, that is*, length and breadth; and *Solid*, which respects both length, breadth and thickness, more than these there is not in Nature.

This premised, I shall not run into the Measurement of all sorts of Figures; but in this place content myself with giving you the general Rule for all four sided Figures, whose opposite sides are Parallel; *which Rule is this.*

Multiply the length by the breadth, and the Product gives the Content.

Exam.

Exam. Suppose the length of a Superficies be 26 Foot 10 Inches, it's breadth 14 Foot 8 Inches, what's the *Area.*

	F.	I.
	26.	10
	14.	8
104	364.	0
26	11.	8
364	17.	4
	6.	8
	393.	6. 8 Parts.

The manner of this Operation is thus, first the several *Denominations* in the *Multiplicand*, are multiplied by the Integers in the Multiplior, then the said several Denominations in the Multiplicand, by the parts in the Multiplior.

As in the preceding *Example.* I multiply 26 Foot by 14 Foot, it gives 364 Foot, then 10 Inches by 14 Foot it gives 140 Inches; *that is*, they are pieces, an Inch broad, and a Foot long, whence 12 of them make a Foot, therefore 140 divided by 12, gives 11 Foot 8 Inches; then I multiply 26 by 8, it gives 208 Inches, which I divide by 12, it gives 17 Foot 4 Inches.

Lastly,

Laſtly, I multiply the 10 Inches by 8 Inches, it gives 80, which are parts of Inches, they being pieces of one Inch long, and the $\frac{1}{12}$ of an Inch broad, and therefore I divide them by 12, it gives 6 Inches 8 parts, all which I place under their proper Denominations, theſe added together gives 393 Foot Inches 8 parts, the content of the foregoing *Superficies*.

6 inches 8 parts

More Examples.

Feet	Inch.		Feet	Inch.	
48.	2		38.	11	
9.	7		27.	9	
432			1026		
1.	6		24.	9	
28.	1.	2	28.	9	
				8.	3
461.	7.	2	1080.	2.	3

tis 1079-11-3-a mistake

Notes, 1. Dimenſions are very ſeldom taken to leſs than Inches, and are ſet down in Feet and Inches one under another, with a Brace againſt them, on the right of which the *Area* is placed *as followeth*.

F.	I.		F.	I.	P.
48.	2	}	461.	7.	2
9.	7				
38.	11	}	1080.	2.	3 — 'tis — 1079 — 11 — 3
27.	9				

'tis a mistake

Secondly, If the work is valued by the Yard or Rod, yet still the Dimensions is taken and cast up in Feet and Inches, and afterwards reduc'd to square Yards by dividing by 9, and to square Rods, by dividing by 272 $\frac{1}{4}$, but most Artificers neglect the $\frac{1}{4}$, and divide only by 272.

Thirdly, That several Works are valued by several Measures, as *Glazing* and *Paving with Free-Stone*, are valued by the Square Foot; *Painting*, *Joynery*, *Plaistering White*, *Washing*, and *Paving* the Streets with *Stone*, are valued by the Square Yard; *Partitioning*, *Flooring*, *Roofing*, *Tyling* and *Slating* by the Square, that is 10 Foot every way, and *Brick-work* by the Rod, which is 16 Foot and $\frac{1}{2}$ Square.

Fourthly, That the Foot is divided into 12 Inches, each Inch into 12 equal parts, called *Parts* or *Primes*, and each *part* or *prime*

prime into 12 equal Parts called *Seconds*, and each *Second* into 12 equal Parts called *Thirds*, &c.

Fifthly, That different Denominations will give different Products.

As Feet multiply'd by Feet, gives Feet.
Feet by Inches, gives Inches.
Feet by Parts, gives Parts,
parts Inches by Inches, gives ~~Parts,~~ [redacted]
Inches by Parts, gives Seconds.
Parts by Parts, gives Thirds.

Sixthly, *Brick-work* is cast up by the Square Rod, (as before has been Noted) which is always to be one Brick and half thick, such a piece of Wall is always accounted a *Rod* of *Brick-work*. If therefore a piece of Brick-work just a Rod Square be thicker or thinner than one Brick and half, 'tis more or less than a Rod.

When therefore it happens, that a piece of Brick-work is thicker or thiner than Brick and half; it must be reduc'd to such thickness, *which is done thus.*

If the Wall be 1 Brick thick, multiply by 2; if a Brick and half Multiply by 3; if two Bricks thick multiply by 4, &c. this reduces

all the Dimensions to half a Brick thick, the Sum of these Dimensions divde by 3, and that Quote again by 272 (neglecting the odd $\frac{1}{4}$) it gives the content in square Rodd of Brick and half thick.

Exam. Suppose the Dimensions of several pieces of Brick-work, with their thicknesses as followeth, what's the Content

[redacted] B	F. I. Pts.
18. 4 / 6. 6 }	238. 4. 0
3 B	
24. 8 / 6. 4 }	937. 4. 0
4 $\frac{1}{2}$	
18. 10 / 9. 6 }	1610. 3. 0

square Feet 3416 : 11 : half Brick thick.

(2
3)3416(

272)1138(4 Rod 50 Foot Cont.

(50

So that in these Dimensions there is 4 Rod, 50 Foot of Brick-work of Brick and half thick.

The Measurement of Solids.

A *Solid* hath *Length*, *Breadth* and *Thickness*.

And therefore to Measure a *Cube* or *Parallelepipedon*.

Multiply the length by the Breadth, and that Product again by the Thickness, the Product is the solid Content.

By this Measure is measured, *Stone*, *Timber*, and digging of Vaults and Cellars.

Exam. A Block of Stone is 8 Foot 6 Inches long, 4 Foot 8 Inches broad, and 3 Foot 2 Inches thick, What's the Content in square Feet?

F.

130 y working
in pag. 333

	F.	I.	
	8.	6	Length.
	4.	8	Breadth.
	32.		
	2.		
	5.	4	
		4	
Superficial	39.	8	Feet.
	3.	2	Thickness.
	117		
	2.		
	6.	6	
	1.	4	
Content in	125.	7 4	Solid Feet.

So that the Content of such a Block of Stone is 125 Foot 7 Inches, 4 Parts. 125 : 7 : 4

Note, Digging is done by the solid Yard, and therefore when you have brought your Dimensions into solid Feet, you must reduce them to solid Yards, by dividing the solid Feet by 27 (the solid Feet in a solid Yard.)

The Measurement of all other *Superficies* and *Solids*, I have shown at large in my *Epitome* of *Geometry*, with the *Demonstration*,

and changing of one Figure to another.

I shall conclude this with giving you the following account of the *Dimension* and *Tale* of several Materials for Building.

A *Brick* by the Statute should be 9 Inches long, 4 $\frac{1}{4}$ Inches broad, 2 $\frac{1}{2}$ Inches thick, 500 makes a Load; but are generally sold by the 1000, *Plain Tyles* for covering Houses are 10 $\frac{1}{2}$ Inches long, and 6 I. broad, these are also sold by the 1000 which is a Load. *Tyles* for *Paving* are some a Foot square, others 10 Inches, they are about an Inch and half thick, and are sold by the Hundred. *Lime* in *London* is sold by the Bag, which should be a Bushel, 25 of these Bags is a hundred of *Lime*. In the Country 'tis sold by the Load, which is about 40 Foot. *Lathes* are sold by the Hundred, of which there is but 5 score of those of 5 Foot long, but 6 score to the Hundred of those of 4 Foot long, their breadth is 1 $\frac{1}{2}$ Inch, thickness $\frac{1}{2}$ an Inch.

Timber is sold by the solid Foot, or else by the Load, 40 solid Foot makes a Tun, 50 Foot a Load, 324 solid Foot; *that is*, 18 Foot square, and a Foot thick is a floor of Timber, 300 Foot of two Inch Plank, 200 Foot of 3 Inch, 150 of 4 Inch Plank, 400 of Inch and $\frac{1}{2}$ Plank, and 600 of Inch Plank makes a Load. *Deal* boards are sold by the Hundred, of which there goes six Score.

Iron

Iron is ſold by the *Tun*, which is 20 C. weight, or 2240 ℔.

Lead goes by the *Fother*, which is 19 C. $\frac{1}{2}$, or 2184 ℔.

Glaſs is ſold by the *Seam*, which is 24 Stone, or 120 ℔. *New-Caſtle* Glaſs has 25 *Tables* in a *Caſe*, 5 ſquare Foot is a *Table*, 45 *Tables* make a *Caſe*. *Normandy* Glaſs 25 *Tables* is a Caſe, which is cut into long Squares, the other Diamond Faſhion.

If one thouſand of Bricks coſt 15 *s.* what coſt 35 Load each 5 C. *Anſw.* 13 *l.* 2 *s.* 6 *d.*

A thouſand of plain Tyles at 19 *s.* 6 *d.* *per* thouſand, what coſt 6 thouſand and a quarter? *Anſw.* 6 *l.* 1 *s.* 10 *d.* $\frac{1}{2}$.

If *Lime* be 5 *d.* *per* Bag or Buſhel, what is that *per* hundred? *Anſw.* 10 *s.* 5 *d.* *per* C.

If a bundle of *Lathes* coſt 1 *s.* 4 *d.* what coſt 45 $\frac{1}{2}$ bundles? *Anſw.* 3 *l.* 0 *s.* 8 *d.*

If a *Deal-board* be worth 14 *d.* what is that *per* C. that is 120? *Aſw.* 7 *l.*

If *Timber* be worth 10 *d.* $\frac{1}{2}$ *per* Foot ſolid, what is that *per* Load? *Anſw.* 2 *l.* 3 *s.* 9 *d.*

If a Rod of *Brick-work* be worth 5 *l.* 5 *s.* what comes 9 Rod 113 Foot to? *Anſw.* 49 *l.* 8 *s.* 7 *d.* *near.*

If the Workmanſhip of a Rod of *Brick-work* be worth 20 *s.* 6 *d.* what is 27 $\frac{3}{4}$ Rod worth? *Anſw.* 28 *l.* 8 *s.* 10 *d.* $\frac{1}{2}$.

If *Tyling* be worth 24 *s. per* Square, or 100 Foot; what is for 8 Square 83 Foot? *Answ.* 10 *l.* 11 *s.* 11 *d.*

If *Stoping*, *Washing* and *Whiting* be worth 1 *d.* ¼ *per* Yard, what comes 2716 Yards to? *Answ.* 14 *l.* 2 *s.* 11 *d.*

If out *Door-painting* be worth 6 *d.* ½ *per* Yard, what will 1486 Yards cost? *Answ.* 40 *l.* 4 *s.* 11 *d.*

If new *Glass* be worth 5 *d. per* Foot, what comes 634 Foot to? *Answ.* 13 *l.* 4 *s.* 2 *d.*

All these Questions are most easily and speedily perform'd by the Rules in Practice.

The following Table is the Comparing of the English Standard Foot, *with the* Standard Foot *of several other Country Measures. By Mr.* John Greaves, *Professor of* Astronomy, *in the* University *of* Oxford.

IF the *English* Foot be divided into 1000 equal Parts, then of these Parts.	1000
The *Roman* Foot contains	967
The Foot of the Monument of *Statilius* in *Rome*	972
The Foot of *Villalpandus*, deduced from the *Congius* of *Vespasian*	986

The

The *Greek* Foot	1007
The *Persian* Foot	3197
The *Venetian* Foot	1162
The *Paris* Foot	1068
Rhinland Foot of *Snellius*	1033
The greater *Turkish Pico* at *Constantinople*	2200
The less *Pico* is to the greater, as 31 to 32.	
The *Dairy* or *Cubit*, at *Cairo* in *Egypt*,	1824
The *Canna* at *Naples*	6880
The *Braccio* at *Naples*	2100
The *Braccio* at *Florence*	1913
The *Braccio* at *Sienna* for Linnen	1974
The *Braccio* at *Sienna* for Woolen	1242
The *Genova* Palm	815
The *Vara Almaria* and *Gibralter* in *Spain*	2760
The *Amsterdam* Ell	2268
The *Antwerp* Ell	2283
The *Leydon* Ell	2260

A
Collection of Questions
To Exercise most of the
Preceding Rules.

By Addition.

1. FRom the *Creation* of the *World* to the *Flood* is 1656 years; from the *Flood* to the calling of *Abraham* 366 Years; from *Abraham* to the giving of *Moses Law* 431; from the giving of the *Law* to the Destruction of *Troy* 347; from the Destruction of *Troy*, to the Building of *Solomon*'s *Temple* 192; from the Building of the *Temple* to the first *Olimpiad* 216; from the first *Olimpiad* to the return of the *Captivity* of *Babylon* 238; from the return of the *Captivity*, to the third *Charthaginian* Conquest by *Scipio Africanus* 336; from the said Conquest, to the Nativity of *Jesus Christ* 202; from the Nativity of *Jesus Christ* to *Constantine*

tine the Great 312; and from *Constantine* the Great to *Charles* the Great 488 Years; the Question is the number of Years from the *Creation* to *Charles* the Great. *Answ.* 4784.

2. *Rome* by *Augustus Cæsar* was divided into 14 *Regions* or *Wards*, in the first was 4 *Temples*, in the second 5, in the third 2, in the fourth 10, in the fifth 6, in the sixth 15, in the seventh 4, in the eighth 21, in the ninth 8, in the tenth 10, in the eleventh and twelfth none, in the thirteenth 6, and in the fourteenth none; the Question is the number of all the *Temples*. *Answ.* 91.

3. The *Moon* runneth thro' the *Zodiack* in 354 days, 8 hours, 48 minutes, which is the *Lunar Year*, and is 10 days, 21 hours, 1 minute sooner than the *Sun*, what is the length of the *Solar Year*, or *Time*, in which the Sun runs thro' the *Zodiack*. *Answ.* 365 *days*, 5 *hours*, 49 *minutes*.

4. In *Scripture* we find mention made of a certain *King* that had the following number of Men to wait upon him, under *Adnah* 300000, under *Jehohanan* 280000, under *Amariah* 200000, under *Eliada* 200000, under *Jehoshabad* 140000, What was the whole number he had? *Answ.* 1120000.

5. The number of the Inhabitants of *London* are reckoned 695718, of *Paris* 488055, of *Rome* 125000, What is the whole number

ber of Inhabitants of these three Cities? *Answ.* 1308773.

6. What's the number of Days contained betwixt the 27th day of *March* 1701. and the 17th of *July* 1702. *Answ*, 471 days.

7. It is reported by *Stow*, that *Brute*, who descended from *Æneas*, built the City of *London* 1108 years before the Nativity of our *Saviour*. How many years is that since? *Answ.* 2812.

8. The Birth of *Jesus Christ* was in the 4714th year of the *Julian Period*, that is, in that year of the *Julian Period*, the *Christian Æra* began, What year therefore of the *Julian Period* is this present year 1705? *Answ.* 6418.

By Substraction.

9. *Queen Ann* was Born in *February* in the year of our *Lord* 1664. How old will she be in *February* 1705. *Answ.* 41.

10. *Prince George* of *Denmark* was Born in *April* 1653. How old will he be in *April* 1705. *Answ.* 51.

11. By Question, the first you may find that the Nativity of *Jesus Christ* was in the the 3984th year of the *World's Creation*, and that *Charles* the Great was in the 4784th year of the *World's Creation*. In what year of *Christ* was *Charles* the Great? *Answ.* in the 800th year.

12. The

12. The number of the Inhabitants of *London* are 695718, and those of *Paris* but 488055, How much doth *London* exceed *Paris*? *Answ.* 207663.

13. The Building of *Rome*, according to *Varron*, was in the 3960th year of the *Julian Period*, and the Birth of *Christ* in the 4714th year of the *Julian Period*, How many years before *Christ*, according to common Computation, was *Rome* built? *Answ.* 754.

14. The number of *Spiritual Promotions* certified in *King Henry* the 8th's Time, amounted to 320180 *l.* 10 *s.* and in the same King's Reign there was taken from the Possession of the Clergy, and Converted to Temporal use, *Promotions* to the value of 161100*l.* 9 *s.* 7 *d.* What remains now to the Clergy? *Answ.* 159080 *l.* 0 *s.* 5 *d.*

15. In the year 1174. *Henry* the 2d. Conquer'd *Ireland*, and annext it to the Title of the Crown of *England*, how long is it to this year 1705? *Answ.* 531.

16. In the year 1296. *Scotland* was Surrendred to *Edward* 3d, How long is it to this present year 1705? *Answ.* 409.

17. In the year 1431. *Henry* the 6th was Crowned King of *France* in the City of *Paris*, How long is it to this present year 1705? *Answ.* 274.

18. *Al-*

18. *Alfred* King of the *West Saxons*, laid the Foundation of *Oxford University*, and of the *Colledge* which beareth that Name, in the year of *Christ* 872, How long is it to this present year 1705? *Answ.* 833 years.

By Multiplication.

19. The whole Circumference of the *Earth* is 360 *Degree*, each *Degree* containing near 70 *English* Miles, What's the *Earths* Circumference in *English Miles*? *Answ.* 25200.

20. In the *Armado* of the *Spaniards* in the year 1588, there were 32000 Soldiers, for whom the necessary Expence amounted each Day to 30000 *Ducatoons*, How much will the Expence be in 6 Months, at 28 days to the Month? *Ans.* 4040000 *Ducatoons*.

21. A Thousand Sail of Ships are employed by the *Dutch* in the *Herring Trade*, each Ship occasions yearly the breeding of 4 *Seamen*, how many after this rate will be rais'd in seven Years? *Answ.* 28000.

22. Every Minute of time the *Heart* of Man absolves 75 *Pulsations*, How many *Pulsations* is that in one Hour? *Answer*, 4500.

23. The necessary Expences for all the People within the Bills of Mortality, counting them 1000000, is moderately computed

ted at 63667 *l. per* day, What is it for one Year? *Answ.* 23238455 *l.*

24. The mean *Semidiameter* of the *Earth* allow'd by the *French*, is 19615800 *Paris* Feet, now the *Space* that *Light* runeth in one Minute of time is 1000 Diameters of this *Earthly Globe*, How many Feet is that in the same time? *Answ.* 39231600000.

25. The mean distance of the *Sun* from the *Earth* is 5000 Diameters of the *Earth*, How many *Paris* Feet is that? *Answer*, 196158000000.

By Division.

26. In the time of Queen *Elizabeth*, the *Groyn* in the Kingdom of *Galicia* in *Spain*, was taken by an *English* Army consisting of 11000 *English*-men, and the Booty they there found was valued at 320000 Gold *Ducatoons*, How many will this amount to for each Man? *Answ.* 29 $\frac{1}{4}$.

27. The mean Distance of the *Moon*, from the *Center* of the *Earth* (as has been hinted) is 1176948000 *Paris* Feet, How many Miles is that at 5000 Feet to the Mile? *Answ.* 235389 $\frac{3}{5}$ *Miles.*

28. The mean Distance of the *Sun* from the Center of the *Earth*, is 19615800000 *Paris* Feet, What's the Distance in Miles? *Answ.* 3923160.

29. If the yearly Value of the *Spiritual Promotions* be 159080*l.* as before was noted, and it were equally to be divided among the Clergy giving them 120 *l.* a Year a piece, how many will it serve? *Answ.* 1325 $\frac{2}{3}$.

30. Admit there be within the Bills of Mortality 1000000 of People as before has been mentioned; now 'tis commonly reported, that 1 out of 30 dies in a Year, What is the number of People that dies within the Bills of Mortality in a Year? *Answ.* 33333 $\frac{1}{3}$.

31. What number is that, which if it be multiply'd by 87, the Product shall be 28362? *Answer.* 326.

32. From this Proposition may be found the length or breadth of any Parallelogram, by having the breadth or length with the *Area* given. As how long is a *Court* or *Yard* which contains 3492 square Feet, and is 18 Foot broad? *Answ.* 194. For 'tis but dividing the given *Area* by the given breadth, and the Quote is the length.

By Reduction.

33. Admit, I employ a Carver at 4 *s. per* day, a Bricklayer at 2 *s.* 8 *d.* a Carpenter at 2 *s.* 6 *d.* and Labourer at 20 *d. per* day, How many days work will 20 *l.* 11 *s.* 8 *d.* pay all these Men (supposing them all to receive

receive for the same number of days) and How much to each Man? *Ans.* 38 days, and the Carver must have 7 *l.* 12 *s.* the Bricklayer 5 *l.* 1 *s.* 4 *d.* the Carpenter 4 *l.* 15 *s.* and the Labourer 3 *l.* 3 *s.* 4 *d.*

33. A Meddalist lays out 4 *l.* 8 *d.* on curious Quoins, *viz.* *French Crowns* at 6 *s.* each, *Portugal Crusadoes* at 3 *s.* 6 *d.* each; *Half Crowns* at 2 *s.* 6 *d.* each, *Gilders* of 20 *d.* each, and 12 *d.* pieces; he buys of all a like Number, How many of each will he have for his 4 *l.* 8 *s.* *Answ.* 6.

By the Rule of Three Direct.

34. A Gentleman spends one day with another 3 *l.* 14 *s.* and lays up at the Years end 250 *l.* What is his annual Income? *Answ.* 1600 *l.* 10 *s.*

35. If I buy 120 Oranges for 3 two Pence, and 120 for 2 two Pence, and then sell them mingled for 5 a Groat, whether do I gain or lose? *Answ.* *I lose* 8 *d.* *by the Bargain,*

36. What number of *Florins* ought I to receive for 94 *l.* 13 *s.* 6 *d.* at 3 *s.* 1 *d.* *per Florin*? *Answ.* 614 $\frac{4}{37}$.

37. If by selling Wax at 2 *s.* 8 *d.* *per* Pound, I gain 14 *l.* *per Cent.* What did it cost ready Money? *Answ.* 2 *s.* 4 *d.* $\frac{192}{2736}$.

38. A

38. A Butcher bought an *Ox*, weighing beside Skin and Legs 868 pound, the Skin and Legs he sells for 21 *s.* 6 *d.* and 15 Stone $\frac{1}{2}$ of Tallow at 4 *d.* $\frac{1}{2}$ *per* pound, What doth a Stone of Beef stand him in, supposing it cost him 18 *l.* 10 *s.* *Answ.* 2 *s.* 10 *d.* $\frac{536}{868}$.

39. A Vintner buys 4 Tun of Wine, which cost 750 *l.* 10 *s.* there chanced to leak out 112 Gallons, How must he sell it by the Gallon, to be no loser by the leakage? *Answ.* 16 *s.* 9 *d.* $\frac{24}{896}$.

40. 'Tis reported of one that made his Will with this Condition, that if his Wife (who was big with Child) was deliver'd of a Son, such Son should have $\frac{2}{3}$ of his Estate, and the Mother the rest; but if she was delivered of a Daughter, the Mother was to have $\frac{2}{3}$, and the Daughter $\frac{1}{3}$, now it happened that the Mother brought forth a Son and Daughter; how must the Estate which was worth 5400 *l.* be divided to fulfil the Will of the Testator? *Answ.* Son 2400 *l.* the Mother 1800 *l.* and Daughter 1200 *l.*

41. What's a Wedge of Gold worth, that weigheth 4 Ounces 16 *d.* weight, 15 Grains at 4 *l.* 1 *s.* *per* Ounce? *Answer*, 19 *l.* 11 *s.* $\frac{159}{480}$.

42. Bought

42. Bought 30 pieces of Cloath for 130 *l.* and sold them again for 150 *l.* now if they had cost 150 *l.* How must they have been sold to have gained after the same rate? *Answer*, 173 *l.* $\frac{1}{13}$.

43. A witty *Scot* upon Contract with an *English* Lady of 4000 *l.* Portion, settles an Estate in *Scotland* of 800 *l. per Ann.* by way of Jointure, but upon Scrutiny into the matter they prov'd *Scotch* Pounds; *that is*, so many five Groats, How much ought he in Justice to abate of the Portion? *Answ.* 3666 *l.* 13 *s.* 4 *d.*

44. A Man died, having 3 Sons, and 2 Daughters, he gave to the Eldest Son 2000 *l.* the Second 1900 *l.* and to the Third 1000 *l.* to the Eldest Daughter 700 *l.* to the other 500 *l.* Now he died and left but 2020 *l.* What must each Child have? *Answer, First Son* 662 *l.* 5 *s.* 10 *d.* $\frac{3}{4}$. *Second Son* 629 *l.* 3 *s.* 7 *d.* $\frac{1}{4}$. *Third Son* 331 *l.* 2 *s.* 11 *d.* $\frac{1}{2}$. *First Daughter* 231 *l.* 16 *s.* 8 *d.* $\frac{3}{4}$. *Second Daughter* 165 *l.* 11 *s.* 5 *d.* $\frac{3}{4}$.

45. An Oilman buys 1750 lb. of Westphalia at 9 *d.* $\frac{1}{2}$ *per* Pound, but having sustained Damage, he is willing to lose 12 *l.* 10 *s.* by the Sale of the whole, At what price *per* pound must he sell it to lose just that Sum? *Answer*, 7 *d.* $\frac{3}{4}$ $\frac{90}{665}$.

A Yeoman, at the Birth of this Daughter, takes by Lease 5 Acres of Land for the term of 25 Years, and Plants it with Acrons,

which in 24 Years time comes to be a Wood of ſtately Oaks, this he ſells, defraying all Charges, for 314 *l.* 19 *s.* Had he planted 27 Acres with equal Succeſs, What would that have amounted to in the ſame Time? *Anſw.* 1700 *l.* 14 *s.* 7 *d.* $\frac{1}{5}$.

47. Dr. *Heylin* tell us in his *Coſmography*, *page* 471. That in the City of *Lunenburgh*, (ſo called, becauſe they there once worſhipped the Moon) there is a Houſe containing 52 Rooms, in each Room is eight Pans, in each of which is boiled once a Week 8 Tun of Salt, each Tun being ſold for 8 Flemiſh Shillings, How much Salt is boiled there in one Year? And what doth it amount to in Pounds *Sterling*, at 7 *d. per Flemiſh* Shillngs? *Anſw.* 173056 Tuns, and 38937 *l.* 12 *s. Sterling.*

48. Receiv'd 350 *l. Sterling* at *London*, to be paid at *Bayon* in *Spain*, for every 6 *s.* 8 *d.* 380 *Marveides*, which I deſire my Factor to return to *London*, that I may gain 10 *l. per Cent.* at how many *Marveides* ought he to return the Pound *Sterling*? *Say*, as 100 : 1140 : 110 : 1254 the *Marveides*, he ought to return the Pound *Sterling* at.

49. Every Minute the Heart delivers 75 Pulſations according to this Proportion, How many will it deliver in an Hour? *Anſw.* 4500.

50. Again it is obſerved, that 4 Ounces *Averdupoize* of Blood is admitted through the

the Heart of Man every *Pulsation*, How much is transmitted every Hour, or in 4500 *Pulsations*? *Answer*, 18000 *Ounces*.

51. The Proportion betwixt the Weight and Blood of a Dog, is as 20 to 1; *that is*, the weight of the Blood is $\frac{1}{20}$ of the Body, now 'tis granted it holds so in human Bodies, whence it will follow, that if a Man weigh 140 ℔. his Blood will be 7 ℔. or 112 Ounces. This admitted, in what time will the whole Quantity of Blood pass through the Heart of Man? *Say*, as 18000: 60: 112? *Answer*, 22 Seconds, *near*.

52. In one second of time sound goes 968 *English* Feet, How far will it run in one Minute? *Answer*, 58080 Foot.

53. The space heavy Bodies descend in, are in such Proportion as the squares of their Times, *that is*, if two Balls descend from the same place, one is stopt at the end of two Minutes, the other at the end of 4 Minutes, then as the square of 2, to the square of 4, so is the space of the first Descent, to the space of the Second. Now 'tis found that heavy Bodies, not far distant from the Earth's surface, by descending move 16 Foot in one second of time, How many Feet will a Body fall in 8 seconds of Time? *Answer*, 1024 Feet.

54. If a Body descend 16 Foot in one second of Time, In what time will it fall

one *English* Mile, or 5280 Feet? *Answer,* 18 *Seconds, near.*

Divide the distance 'tis to fall by 16, *then the square Root of the Quote is the Answer.*

By the Rule of Three Reverse.

55. I lent my Friend 250 *l.* for 5 Months, How much must he lend me for 9 Months to Ballance my Kindness? *Answ.* 138 *l.* $\frac{8}{9}$.

56. Suppose my Friend did borrow of me 750 *l.* for 8 Months, and that he lent me 860 *l.* How long must I keep it? *Ans.* 6 $\frac{84}{86}$ Months.

Questions relating to the Genesis *and* Analisis *of Powers;* that is, *to the raising of Powers, and extracting of Roots.*

57. In an *English* Mile is 5280 Feet, How many square Feet is contained in a square Mile? *Answ.* 27878400. Now if every Man be allowed the space of 3 square Feet, then a square Mile will contain 9292800 Men.

58. Suppose then with the *Ingenious Tacquet.* That the World may endure 10000 Years. That the number of human Kind alive at one time be 1000000000. And that within the space of 50 Years 1000000000

to

to have departed this Life, and in the ſame time the like Number to have been born. It will then follow that the Number of Mankind from the Creation to the end of the World will be 200000, 000000. Now, if 2 or 3 ſquare Feet be aſſigned for each Perſon it will be made manifeſt, that 150 ſquare *Engliſh* Miles will be ſufficient to contain the whole Multitude of humane Race; 'tis therefore required, How many ſquare Feet are in 150 ſquare Miles? *Anſwer*, 627264000000. But 200000000000 Perſons poſſeſs no more than 400000000000 ſquare Feet, if two ſquare Feet be allowed to every Perſon, and 600000000000 if three be allowed.

59. How many Cubical Feet is contained in a Cubical *Engliſh* Mile? *Anſwer*, 147197952000.

60. Again, the number of humane Bodies being 200000000000, and ſuppoſe every Man upon the Superficies of the Earth to take up two, or three ſquare Feet; *that is*, allowing each Perſon 6 Foot high; the ſpace that each human Body takes up will be 12 or 18 Cubique Feet, ſo that 200000000000 humane Bodies, may take up the ſpace of 2,400000,000000, or 3. 600000000000 Cubick Feet, from which it's evident, that the whole Maſs of Mankind may be contained in leſs than a Cube, whoſe ſide is three Mile, the ſolidity of which

which is 3,974344704000 ſolid Feet.

61. Suppoſe, I would encloſe a ſquare Piece of Ground containing 2209 ſquare Perches, How long ought the ſide of another ſquare Field to be 4 times as big? *Anſw.* 94.

62. The length of a long ſquare Field is 48 Perches, the breadth is 34, What's the ſide of a ſquare Field that is equal to it? *Anſw.* 40 Perches, 3 Tenths.

And thus the ſide of a Square, equal to any given Superficies may be found, viz. *by Extracting the ſquare Root of the* Area.

63. Suppoſe a Roper gave to his Daughter a Rope with 20 Knots in it for her Portion, to each Knot was tied 20 Purſes, and in every Purſe was 20 Guineas, What had ſhe for her Portion? *Anſw.* 8000 Guineas.

64. To find a Cube equal to any other Veſſel, *Example,* I would know the ſide of a Cube, that holds juſt a Hogſhead, *viz.* 63 Gallons? *Anſwer,* 27 In. *near.*

65. Admit a piece of Timber be 15 Inches ſquare, What muſt be the ſide of another piece 6 times as ſtrong? *Anſwer,* 36 *near.*

66. I ſhall conclude theſe Collection of Queſtions, as alſo, the whole Book with the following Experiment and Account, which require an Arithmetick Calculation.

By an Experiment the learned Dr *Halley* made at *Greſham Colledge,* he found that

in the ſpace of 12 Hours, in a Summers Day, there did Evaporate $\frac{1}{10}$ of an Inch from the Surface of any Veſſel of Water. Whence every 10 ſquare Inches Surface of Water, will yield in Vapour a Cube Inch of Water. Now 28 $\frac{7}{8}$ Cubick Inches is a Wine Pint. This granted, 'tis required to find what Quantity of Water will Evaporate in one days time from the whole Surface of the *Mediterranean*, which in a Medium may be admitted to be 40 *Degrees* long, and 4 *Degrees* broad.

From theſe Dimenſions 'tis evident, the *Mediterranean* will contain 160 ſquare *Degrees* of Sea, and conſequently 761760 ſquare Miles, now upon this Suppoſition that every 10 ſquare Inches yields a Cube Inch of Water *per Diem*, and ſo each ſquare Foot was near $\frac{1}{2}$ a Wine Pint, then every ſpace of 4 Foot ſquare will yield a Gallon, and a ſquare Mile 6914 Tuns, and therefore a ſquare *Degree* of 69 *Engliſh* Miles will Evaporate 33 Millions of Tuns, and conſequently the whole *Mediterranean* will loſe in a Summer's Day 5280 Millions of Tuns of Water.

67. The ſaid Dr. *Hally* gave an account at another meeting of the *Royal Society*, of the exceeding thineſs of Gold, which he computes from the account he had from the *Gold Wyer Drawers*, which was this, the beſt double Gilt Wyer is drawn from a

a Cylendrick Ingot of Silver 4 Inches in Circumference, and 28 Inches long, which weighs 18 pound *Troy*, this is covered with 4 Ounces of Gold, that is 48 Ounces of Silver to one Ounce of Gold, this they draw into such fine Wyer, that 2 Yards of it weighs but a Grain; whence 'tis evident, that 98 Yards of such Wyer weighs 49 Grains, and consequently that one Grain of Gold covers the said 98 Yards, and that the $\frac{1}{10000}$ part of a Grain is above $\frac{1}{3}$ of an Inch long, which may be actually divided into 10 equal Parts, and so the $\frac{1}{100000}$ of a Grain of Gold visible without a Microscope.

But to proceed, he tells you in the same place, that the thickness of such Wyer is the $\frac{1}{386}$ of an Inch, and then the Circumference of such will be but $\frac{1}{123}$ of an Inch, *near*. therefore 123 Grains of Gold cover 98 Yards long, and an Inch broad, that is 24 Foot $\frac{1}{2}$, this being granted, I demand how much Gold will cover a square Mile, *that is*, 640 Acres? *Answ.* 24298 ℔. 9 Ou. 6 Dwt. 2 Gr.

If any Faults have Escap'd Correction, they may be Amended by any Person from a Correct Copy, at the Author's House in Channel-Row, Westminster.

FINIS.